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K. Akademie d. Wissenschaften,
München (Munich)
Bavaria.

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DESCRIPTION

*H. Akad. d. Wissenschaften,
mit Hochachtung des Verfassers.*

OF

VERTEBRATE REMAINS,

CHIEFLY FROM THE

PHOSPHATE BEDS OF SOUTH CAROLINA.

By PROF. JOSEPH LEIDY.

PRESENTED FOR PUBLICATION, OCTOBER 31, 1876.

EXTRACTED FROM THE JOURNAL OF THE ACADEMY OF NATURAL SCIENCES, VOL. VIII.,
PHILADELPHIA, 1877.

ISSUED SEPTEMBER 6, 1877.

PHILADELPHIA:
COLLINS, PRINTER, 705 JAYNE STREET.
1877.



Description of Vertebrate Remains, chiefly from the Phosphate Beds of South Carolina.

By Prof. JOSEPH LEIDY.

DURING the past two years the leisure of the writer of the present communication had become so much occupied in another field of investigation that until a few weeks ago he had no idea of doing anything again so soon in the way of palæontological research. The recent great International Exhibition, established in commemoration of the centennial existence of the United States, with a profusion of other matters of interest, has brought to his notice, in the agricultural department of the government building, and in various collections of manufacturing companies of fertilizers, many fossils obtained from the so-called Ashley Phosphate Beds of South Carolina. Among the fossils there are a number of sufficient importance to command attention while the opportunity exists of examining them, for in most cases they are likely to be lost to the inspection of students after the great exhibition closes.*

Want of sufficient time and the means of making the requisite comparisons have prevented the determination and description of the greater number of the fossils, especially of the numerous Cetacean vertebræ, and the teeth of Sharks, wonderful for their multitude and variety as some of them are for their size. So much uncertainty and confusion prevail in the reference of teeth of extinct Sharks to genera and species, that until some one who has the opportunity will afford us the means of making comparisons by publishing good figures of the entire series, in all its varieties, of the dentition of the living Sharks, we cannot hope to give a satisfactory account of the fossil teeth.

The Ashley Phosphate Beds, as they are commonly called, of South Carolina, now extensively explored for their stores of fertilizing materials, are composed of sands and clays, intermingled with irregular porous masses of more coherent rock rich in calcium phosphate, together with many organic remains. These beds, the economical importance of which was fully made known in 1868 by Prof. Francis S. Holmes and Dr. N. A. Pratt, of Charleston, occupy a large extent of country in the southern part of South Carolina, on the Wando, Cooper, Ashley, Stono, Edisto,

* The finder and unscientific owner of fossils, ignorant of their real importance, often retain them as curiosities, with exaggerated notions of their pecuniary value, and no argument is sufficient to induce them to part with the specimens or place them where they may be accessible to the student.

Coosaw, Ashepo, and other rivers. According to Prof. Holmes, from "fifteen to eighteen inches may be considered the average thickness of the stratum of the phosphate rocks."*

The exact stratigraphical relations of the beds and the relative age of these and contiguous strata have not been as thoroughly investigated as is desirable, and in many cases the particular horizon to which belong the fossils that have been discovered has not been positively determined. According to Prof. Holmes the phosphate beds are of the post-pliocene period and overlie strata pertaining to the pliocene period, and these are again succeeded by a soft marl rock of eocene age, the whole being covered by modern alluvium.

The phosphatic rocks, or nodular masses of the phosphate beds, said to contain as high as 60, or even more, per centum of calcium phosphate, are of irregular shape, and range in size from small pieces up to masses of a thousand pounds or more.† They contain many casts of molluscos shells, which appear to be of the same forms as those which occur in the eocene or miocene marl rock beneath. They also frequently contain imbedded bones and teeth, mainly those of marine Fishes and Cetaceans.

The phosphatic nodules are supposed to have been derived from the tertiary marl bed beneath, and are considered to be detached and altered fragments from the surface of that bed. The irregular, eroded, and porous masses have the appearance of being detached and water-rolled fragments of the tertiary marl rock after it had been tunnelled by various boring mollusks. It is, indeed, not improbable, as has been suggested, that in the later part of the eocene or miocene period and subsequently the easily penetrated rock was bored and rendered spongy by the incessant labors of multitudes of *Gastrochæna*, *Petricola*, *Pholas*, etc. At the time or later, neighboring and superficial islets, the resorts of myriads of sea fowl, may have furnished the material which, when washed with the ocean and mingled together with the decomposing remains of marine animals, supplied the element for conversion of the porous marl rock into the more valuable phosphatic compound.

Besides the phosphatic nodules, the Ashley beds present a remarkable intermixture of the remains of marine and terrestrial animals, consisting of bones, teeth, coprolites, shells, etc., derived from the contiguous formations of various ages from the early tertiary to those of a comparatively recent period.

Of remains of Vertebrates, those of Fishes and Cetaceans prevail, especially the teeth of Sharks and the vertebræ of Whales. Less frequently there occur the ver-

* The Phosphate Rocks of South Carolina. By Francis S. Holmes, A.M. Charleston, 1870, p. 70.

† A nodular mass, on exhibition in the Government building, from Charleston, S. C., weighs 1150 pounds.

tebræ and teeth of large teleost Fishes, the dental pavements of Rays, fragments of Turtle shells, vertebræ of Crocodiles, ear-bones and teeth of Cetaceans, bones of Manatees, etc. With these likewise are found the remains of both extinct and still existing terrestrial mammals, especially teeth and bone fragments of Elephant and Mastodon, Megatherium, Horse, Tapir, Bison, and Deer. More rarely there are found remains of Hipparion, Castoroides, Hydrochærus, and of the smaller and more common genera and species.

The fossils mainly consist of the harder parts of the skeleton and of teeth, usually more or less water-worn, indicating shallow seas and an active surf to which they were exposed. Many of them exhibit the drilling effects of boring mollusks, especially those which are supposed to have been derived from the tertiary marl rock, the operation of drilling apparently having been performed both before and during the time the fossils were imbedded in the rock. Only enamel or the enamel-like dentinal layer such as is found investing the crown of the teeth of Sharks, appears to have been a protection against the drilling power of the borers.

Fossils excavated from the phosphate beds are of a ferruginous brown color, but often much lighter or white upon the surface. Those which are obtained from the rivers contiguous to the beds are usually more or less black, with the enamel of teeth iron-gray, and they frequently exhibit the basal attachment of small barnacles, and occasionally the valve of an oyster.

From the fossils consisting mainly of the harder and denser, and therefore heavier parts of skeletons and teeth, they are generally assumed to be petrified, but usually the change has not been more than a moderate loss of the ostein basis and the infiltration of iron oxyd.

From the extraordinary variety and profusion of the fossil remains of the Ashley phosphate beds it may be inferred that these were the former rich feeding grounds for multitudes of marine and amphibious animals. At an early period during the formation of the tertiary marl, here congregated great Sharks, Rays, Squalodons, etc. At a later period their successors varied their diet with the carcasses of great land animals, as Elephants, Mastodons, etc., which floated down the broad and swollen rivers, as drowned herds of the Bison are said to do in our day upon the Missouri River.

Some of the remains of terrestrial animals, comparatively few in number, found as fossils in the Ashley phosphate beds, including even the softer or more spongy bones, exhibit no evidence of violent water action other than the signs of decay from the combined influence of moisture and air; neither do such fossils exhibit the marks of boring mollusks, nor the attachments of barnacles. Usually black

and more or less friable, these fossils, such as the bones of Mastodon, Megatherium, Deer, etc., are no doubt the remains of animals which became mired and sunk into marshes of the Ashley phosphate beds after these had become elevated above the surface of the neighboring sea. Of this nature also, we may believe, are the remains of more recent animals, including also specimens of human bones, those of domestic animals, and stone implements, which are occasionally found in the Ashley phosphate beds.

EQUUS.

Molar teeth of Horses apparently referable to the two species which have been named *Equus major* s. *complicatus* and *E. fraternus*, are among the more frequent remains of terrestrial mammals found in the Ashley deposits. The different collections of materials from the latter displayed at the International Exhibition contain a number of specimens of teeth. The lower molars of both named species and the upper ones supposed to pertain to *E. fraternus*, present nothing distinctive from the corresponding teeth of the recent Domestic Horse; so that some of the specimens no doubt really pertain to the latter. The additional specimens of teeth from the Ashley deposits which I have seen, give no further information than those which have been described and figured in Holmes' Post-pliocene Fossils of South Carolina.

HIPPARION.

HIPPARION VENUSTUM.

Leidy: Proceedings Academy of Natural Sciences of Philadelphia, 1853, 241.

Hippotherium venustum, Leidy: Holmes' Post-pliocene Fossils of South Carolina, 1860, 105, Pl. xvi., figs. 32, 33.

Of *Hipparion* I have seen no other specimens, though I have industriously searched for them in the different Ashley collections, except those described and figured in Holmes' Post-pleiocene Fossils of South Carolina under the name heading this paragraph.

ELEPHAS.

ELEPHAS AMERICANUS.

Dekay: Nat. Hist. New York; Zoology, 1842, I., 101.

Remains of the American Elephant, chiefly molar teeth or fragments of the same, consisting of isolated enamel plates or several conjoined by the more or less decomposed intervening cementum, are frequent fossils of the Ashley phosphate

beds. An entire well-preserved molar, the last of the lower series, from the property of the Marine and River Mining Company at Beaufort, S. C., is contained in the Ashley collection of fossils of the Smithsonian Institution at the International Exhibition. Most collections of Ashley fossils of moderate extent contain fragments of Elephant molars, but rarely of bones.

All the specimens of molars from the Ashley beds which I have had the opportunity of inspecting, belong to the coarse plated variety, which Dr. Falconer referred to a species distinct from the *Elephas primigenius*, under the name of *E. columbi*. For reasons elsewhere given I have been disposed to consider most of the Elephant remains of North America, including molar teeth with comparatively thin plates, as pertaining to a common species under Dekay's name heading the present article.

MASTODON.

MASTODON AMERICANUS.

Leidy: Proceedings Academy of Natural Sciences of Philadelphia, 1868, 175.

Remains of the common American Mastodon, principally consisting of molar teeth and fragments, together with portions of tusks, are of frequent occurrence among the Ashley fossils. The Smithsonian collection of the latter at the International Exhibition, besides fragments of teeth, contains a well-preserved last inferior molar from the Coosaw River.

Besides remains of the former species, from the same beds, I have seen small fragments of molar teeth such as I have considered to pertain to another species under the name of *Mastodon obscurus*. Several such fragments of upper molars are contained in the collection of the Pacific Guano Company.

MEGATHERIUM.

Remains of the Megatherium are occasionally found in the excavations of the Ashley phosphate beds. In Holmes' Post-pliocene Fossils of South Carolina, 1860, page 111 (Pl. xx., fig. 8), a notice is given of fragments of teeth from this locality. The collection of the Pacific Guano Company contains a well-preserved specimen, represented in figs. 42, 43, Pl. xxxiv., consisting of the upper part of a tooth, the first of the series of the left side of the lower jaw. It accords in form, proportions, and size sufficiently near to the corresponding tooth of a cast in plaster of the lower jaw from the skull of *Megatherium americanum*, preserved in the British Museum, to belong to the same species.

A fragment of the lower extremity of a femur of the Megatherium from the
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Ashley phosphate beds was recently presented to the Academy by Mr. George T. Lewis. It comprises a portion of the shaft with one condyle and the trochlea of the patella, and accords in size and other characters with the corresponding portion of the same bone in the South American Megatherium. What remains of the specimen is well preserved, but is not petrified. It is black, like the tooth above described, but is not water-worn, nor does it exhibit any of the marks of boring mollusks or attachments of others, so frequent among the marine fossils of the Ashley beds. It perhaps belonged to an animal which became mired and perished when the Ashley beds were elevated above the sea level and formed marsh lands.

MANATUS.

MANATUS ANTIQUUS.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1856, 165; Holmes' Post-pliocene Fossils of South Carolina, 1860, 117, Pl. xxiv., figs. 5-7.

The collection of Ashley fossils, of the Pacific Guano Company, contains many remains of a Manatee, consisting mainly of rib fragments, mutilated vertebrae, and fragments of skulls, but none are sufficiently characteristic to determine positively whether they indicate a species different from its existing representative living further south. Among the specimens there are four which consist of that part of the skull formed by the summit of the occiput and the contiguous portions of the parietals. These, though exhibiting trifling variation, are yet sufficiently like the corresponding portion of the skull of our recent Manatee to belong to the same species.

A tooth of a Manatee from the same locality described and figured by me in Holmes' Post-pliocene Fossils of South Carolina, is sufficiently distinctive to pertain to a species different from our recent one, and it is probable that the bones above indicated may belong to the same species as the fossil tooth, with which they accord better in their larger size.

ROSMARUS.

ROSMARUS OBESUS.

s. *Trichecus rosmarus*.

The present southern limit of the Walrus on our coast is the northern part of Labrador. A century ago the animal existed among the Magdalen Islands in the Bay of St. Lawrence, and even as far south as Sable Island, Nova Scotia; but in these localities it has been completely exterminated. Remains, discovered at different points along the coast, have been described or referred to, indicating the further extension of the animal at an earlier period as far south as Virginia.

No remains of an undoubtedly extinct species known to me have been discovered anywhere. Dekay (Nat. Hist. New York, Zoology, I., 1842, p. 56, Pl. xix., fig. 1) notices a specimen, consisting of the facial portion of a skull of a Walrus, found on the shore of Accomac Co., Virginia, which he refers to an extinct species with the name of *Trichecus virginianus*. He gives as its characters: "Cheek teeth with obliquely truncated crowns, not ridged; the second smaller than the first." These apply to the recent animal as well, and therefore do not justify the reference of the specimen to an extinct species.

Among the collection of Ashley fossils of the Pacific Guano Co., submitted to my inspection by Mr. J. M. Gliddon, there is a specimen of a Walrus tusk with perhaps sufficient peculiarity to infer a species different from the living one, though I suspect the peculiarity is of an individual varietal, and perhaps partly of an accidental character.

The specimen, represented one-third the natural size in figure 6, Pl. xxx., is as black as ebony; dense, heavy, and brittle, and has been broken by an accidental blow of the shovel into a number of pieces. These have been cemented together, and the tusk appears nearly complete, except at the thin border of the pulp cavity. The inner curvature is slight, and it indicates the tooth to be of the left side.

In robust character the tusk quite equals those of the largest mature recent skulls which have come under my observation, but is much shorter and more abruptly tapering. The specimen looks like what we might suppose the tusks of the living animal would, were they broken off near their middle and then worn away little more than one-fourth the length in a curved line deflected from the course of the anterior longitudinal convexity to the tip. The comparative brevity of the tusk and its worn condition at the end may perhaps have depended on just such an accident and subsequent wear.

In a mature skull obtained from the shore of Sable Island, and preserved in the museum of the Academy, the tusks, which are of the usual size, are worn in the same manner as in the Ashley specimen for more than half their length.

The inner side of the Ashley tusk is fluted in front and behind the middle. The intermediate ridge is the most prominent, and the posterior ridge is further defined by a groove descending and disappearing before reaching the middle of the tusk. The outer side of the fossil is also fluted, though not so conspicuously, and the furrows disappear below the middle of the tusk. The arrangement on the inner side of the specimen resembles that on the outer side of a large pair of tusks in a mature recent skull, contained in the collection of the Academy, more than it does that on the same side of these. The fluted arrangement of the tusks of the

Walrus is, however, subject to variation, and cannot, as far as relates to the condition observed in the fossil, be considered of specific value. Variation in the exact arrangement of the fluting is exhibited in the tusks of the Sable Island skull above mentioned, and in those of a skull found in Monmouth Co., New Jersey, also contained in the collection of the Academy.

While we cannot consider the characters presented by the fossil tusk as of sufficient value to determine positively whether it pertained to a species of Walrus distinct from the living one, it is an interesting fact to have learned that this or a closely related species formerly existed so far south as the Ashley River, South Carolina.

The length of the tusk following the curve externally is 13 inches; near the root fore and aft it measures $3\frac{1}{2}$ inches, and transversely $1\frac{1}{2}$ inches; at the middle about the same fore and aft, and $2\frac{1}{2}$ inches transversely.

DINOZIPHIUS.

DINOZIPHIUS CAROLINENSIS.

Teeth not differing from those of the recent Sperm Whale have been discovered in the Ashley phosphate beds. Two such teeth are indicated and described in Holmes' Post-pliocene Fossils of South Carolina. In the Ashley collection of fossils of the Pacific Guano Co. there is a large tooth, which from its form I infer to have belonged to a species different from the recent one, and it is not improbable that it may have pertained to a huge Ziphoid Cetacean.

The specimen represented in figure 6, Pl. xxxiv., one-half the size of the original, is black, dense, heavy, and brittle, but not petrified; and it has the same structure as the teeth of the Sperm Whale. It is fusiform with only slight lateral compression, and is nearly straight or feebly curved. It is most robust at the upper third or crown, and is in this position blunt, conical, and devoid of any trace of enamel. The fang is an elongate cone with a small funnel-shaped pulp cavity at the apex less than an inch in depth.

In size and form the specimen resembles certain large teeth from the Antwerp crag, such as are represented in the magnificent "Osteographie des Cétacés" of Van Beneden and Gervais, Pl. xx., figs. 29-32, under the names of *Dinoziphius Raem-dorkii* and *Eucetes ambliodon*, which Prof. Gervais regards as the same. As the animal to which the Ashley fossil tooth pertained lived in the same ocean and may have been contemporary with those animals to which the Antwerp crag teeth belonged, it is not improbable that all were of the same species.

The length of the tooth is $8\frac{1}{4}$ inches; its greatest diameter, three inches from the summit, is $3\frac{3}{16}$ inches, and the lesser diameter in the same position is $2\frac{7}{8}$ inches.

CETACEAN TEETH.

A specimen of a tooth resembling those of the Sperm Whale, represented in figure 7, Pl. xxx., was derived from the Ashley phosphate beds. It is nearly complete, except at the lower extremity, where it exhibits the summit of a conical pulp cavity. It is slightly curved, slightly compressed cylindroid below, and blunt conical at the free end. It is furnished with a thin layer of cementum, through which the dentine protrudes at the end of the crown. In portions deprived of the cementum the circular lines of growth of the dentine are quite obvious. In its present condition the tooth is about $4\frac{1}{2}$ inches long; its greatest diameter below is 16 lines; its shorter diameter in the same position, 15 lines.

Another specimen, represented in figure 8, Pl. xxx., from the same beds, in its complete state, was a little larger than the former. The fang is solid to the broken extremity, and the end of the crown was worn all around into a cone with the apex directed inwardly. The tooth appears nearly straight and cylindric throughout the greater part of its length. The cementum is broken away, except a portion internally, where it is $2\frac{1}{2}$ lines thick. The exposed dentine conspicuously exhibits the circular lines of growth. The specimen in its present condition is $3\frac{1}{2}$ inches long.

A small tooth, represented in figure 9, Pl. xxx., from the Ashley beds, is black, dense, and lustrous. It has the end of the fang and crown broken off, and is smooth and water-worn, which the former specimens appear not to be to any marked degree. The tooth is oblique in its axis instead of appearing curved. The fang is rounded trilateral, and exhibits thick circular striæ of growth. The crown is conical and defined from the root. Its surface is smooth, shining, and feebly striate longitudinally, and it has an indistinct appearance of being invested with a thin enamel layer, though I have been unable to determine positively whether such exists. The specimen in its present state is $1\frac{1}{4}$ inches long; the diameters at the base of the crown are 8 and 7 lines.

This tooth bears some resemblance to one from the Red Crag of Suffolk, England, represented in fig. 23, in a paper of Prof. Owen, in the Quarterly Journal of the Geological Society of London for 1856. The Red Crag tooth is referred by Prof. Owen to a Grampus, *Phocæna*.

A mutilated Cetacean tooth, represented in figure 10, Pl. xxx., is from the miocene marl of Nash Co., North Carolina, and was presented to the Academy by Dr. O. D. Coppedge. It is curved cylindroid, with the root flattened on the inner side. The crown has had a cap of its dentine broken away, and in its present

condition is conical. The surface of the fang exhibits strongly the concentric edges of the dentinal layers composing the tooth, which perhaps have been thus rendered so conspicuously evident by the eroding action of the ocean water. The end of the fang presents a shallow half conical pulp cavity. The specimen in its present state is less than three inches long, and 10 lines by 9 lines in its thickness.

Figure 11, Pl. xxx., represents what appears to be a small Cetacean tooth, found with the preceding specimen in the marl of Nash Co., N. C. It is solid throughout, the lower extremity having been broken squarely off. It is curved cylindrical with a worn conical point. It appears to be devoid of a cemental layer, and below the conical summit exhibits a close series of circular striæ of the dentinal laminae. The length of the specimen is 14 lines; its thickness, $2\frac{1}{2}$ lines.

ZIPHIROID CETACEANS.

The Ziphioid Cetaceans, of which remains appear to be frequent among the fossils of the South Carolina phosphate beds, belong to the sub-order of the Odontocetes, or Toothed Whales, although they are almost destitute of the organs from which these are named. They have no functional teeth in the upper jaw, and with the exception of one, or at most two pair, they are absent in the lower jaw. The rostrum or forepart of the skull is elongated and remarkable for its dense ivory-like character, which often leads detached fossil specimens to be considered as being petrified.

CHONEZIPHIUS.

The genus *Choneziphius*, to which I suppose several of the Ashley fossils belong, is thus characterized by Prof. Gervais:—Independently of the form of the rostrum, in which the intermaxillaries are co-ossified at their internal border and the maxillaries are so united inferiorly as to permit only a narrow portion of the vomer to be seen, the genus is also distinguished by the want of ossification of the supra-vomerine cartilage, the absence of which leaves a fistulous excavation extending the length of the rostrum. Interocular space broad and flattened; a pair of infundibuliform fossæ occupying the region near the external nares, with the right fossa much larger than the left, and each ending in a vascular foramen which penetrates the rostrum by extending into the intermaxillaries.

CHONEZIPHIUS TRACHOPS.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 81.

The species is indicated by a specimen found in the Ashley phosphate beds worked by the Pacific Guano Co., and is represented in fig. 2, Pl. xxx., and fig. 1,

Pl. xxxi. It consists of the rostral portion of the skull of a Ziphioid Cetacean, detached in the position of the nasal passages. The end of the beak is lost and a portion of the anterior extremity of the intermaxillaries is broken away, so as to expose half the length or more of the vacant supra-vomerine canal.

In its present state the specimen measures twenty-one inches in length. All the bones entering into its composition, consisting of maxillaries, intermaxillaries, and vomer, are completely co-ossified, so that it is difficult to assign to the different ones their exact limits. The fossil is almost ivory-like in density and very heavy, as usual with the rostrum of most members of the family. The condition of ossification in its solidity resembles that of the bones of the Walrus and Manatee, and as in these, often misleads persons to consider the state to be due to petrification.

The specimen, like most of the Ashley fossils, is water-worn, and in many places exhibits the boring effect of such mollusks as *Gastrochæna*, *Petricola*, etc. It likewise presents a number of attached basal plates of small barnacles, apparently of more recent date than the borings of the mollusks.

In most respects the specimen bears resemblance to a nearly corresponding one from the crag of Antwerp, originally described and figured by Cuvier (*Ossements Fossiles*, T. 8, p. 245, Pl. 228, fig. 7) with the name of *Ziphius planirostris*, and subsequently referred to another genus by Duvernoy (*An. Sc. Nat.* 1851, 43), under the name of *Choneziphius*. Good figures of the same specimen are given in the *Ostéographie des Cétacés*, by Van Beneden and Gervais, Pl. xxvii., fig. 5, with which those of our figures in Pl. xxx. and xxxi, reduced to the same scale, may be compared.

The specimen viewed from above, fig. 2, Pl. xxx., presents a long narrow triangle with an expanded base corresponding with the interocular or prenasal region. The sides of the triangle in converging towards the end of the beak, present a slight swell outwardly near the middle, but they are not exactly symmetrical.

The unequal and unsymmetrical prenarial fossæ occupying the median portion of the interocular space of the cranium are moderately concave, compared with their condition in *Choneziphius planirostris*. Shelving downward and forward from their broadest position bordering the nasal orifices, they converge in a funnel-like manner into a pair of grooves extending along the upper part of the beak in the line of conjunction of the maxillaries and the intermaxillaries. The right prenarial fossa is very much larger than the left one, measuring at its widest part three and three-quarter inches, while the latter in a corresponding position is only a little over two inches wide. Externally the prenarial fossæ are defined by a curved ridge, which appears to form the outer border of the intermaxillaries.

Just in advance of the nares they are separated by an irregular notch narrowing forward into a shallow irregular groove, about two inches long, which apparently indicates the original sutural disconnection of the intermaxillaries. The notch is partially occupied by a thin ridge which appears to be an extension of the nasal partition or mesethmoid bone.

The grooves proceeding forward from the prenarial fossæ, about seven inches in advance of the nares, are somewhat constricted, and just preceding this constriction the prenarial grooves communicate each with a large intermaxillary foramen continuous with a canal descending forward within the intermaxillary bone.

The median position of the beak between the prenarial grooves is occupied by a prominent ridge formed apparently by the union of the two intermaxillaries. The forepart of this ridge in the specimen is broken away, leaving exposed to view the supra-vomerine canal, extending forward as a deep groove to the end of the beak. The intermaxillary ridge widens at its summit in passing backward and forms an unsymmetrical clavate prominence, bending to the left, between the position of the prenarial fossæ. The posterior rounded extremity of the ridge is continuous with the irregular elevated borders of the groove separating the back part of the prenarial fossæ, and the groove just mentioned is continuous with a short fissure upon the intermaxillary ridge. The latter, if I am not mistaken, is considered by Prof. Owen as pertaining to the prefrontals, and not to the intermaxillaries; the prefrontals being, as I understand the matter, homologous with the narial septum and the mesethmoid cartilage when this exists in this condition. The intermaxillary ridge, as I have described it, in the fossil, forms the roof of a long canal, made vacant from the destruction of the mesethmoid cartilage, extending from the position immediately in advance of the nasal passages all the way to the end of the beak. If then the cartilage removed from the supra-vomerine canal is regarded as an extension of the prefrontals, the ridge roofing over the canal at the back as well as at the forepart of the beak I would suppose to belong to the conjoined intermaxillaries.

The supra-vomerine canal, for the accommodation of the mesethmoid cartilage, extending throughout the length of the beak, is large and laterally compressed cylindroid, about three-fourths of an inch perpendicularly and half an inch transversely.

The maxillaries on the upper part of the base of the beak, outside the position of the maxillo-intermaxillary groove, exhibit a conspicuous rugged tract, such as is also described and represented to exist in *Choneziphius planirostris*. The two tracts are not quite symmetrical, that of the right side being more developed. The

right one is the wider, and extends further backward and outward, though not so far forward as the left one. The right tract is about six inches long and one and three-fourths wide near its middle.

In another fossil specimen from the same collection, and consisting of a fragment of the right maxillary bone from a larger individual, the corresponding rugged tract is eight inches long and nearly two inches wide.

Back of the rugged tract, in the fossil under special examination, the surface is extended in a broad crescentoid groove, outside the position of the prenasal fossa, forming part of the supra-orbital fossa of the maxillaries. A large foramen just behind the rugged tract opens outwardly into a channel from the anterior division of the infra-orbital canal.

Laterally, the upper surface of the beak is defined posteriorly from the palatine surface by a subacute ridge. This proceeds forward, and near the middle of the beak divides into two branches which, continuing to advance with slight divergence, subside near the end. On the left side the principal ridge advances several inches further than the right, and its branches are less conspicuous. In the fork of the branches a neuro-vascular canal opens forward into a groove which gradually becomes obsolete in front.

In the side view of the beak (fig. 1, Pl. xxxi.) the median intermaxillary ridge appears as its most elevated outline, but at the base the back end of the rough tract of the maxillaries rises nearly to the same level. The lower outline forms a moderate inflection between the end of the beak and the deep antero-posteriorly convex carina intervening to the broad depressed surfaces for the palatines and pterygoids.

Viewed beneath, the back of the beak exhibits a prominent carina with deep sloping surfaces extending to the lateral subacute borders. The deep slopes present broad, shallow, concave depressions for the palatine bones which are separated from the lateral borders of the beak by narrower groove-like concavities.

The median palatine carina is acute just in advance of the inferior nares, becomes obtuse forward, and gradually expands on the transversely convex under-surface of the anterior two-thirds of the beak. The acute portion of the carina is continuous backward with the nasal partition, and its sides are impressed by the pterygoids. This portion of the carina appears to be formed by the vomer, and is the only portion of that bone seen on the under part of the beak.

The anterior two-thirds of the beak beneath form an elongated demi-cone not exactly symmetrical on the two sides. No trace is visible of the original median separation of the maxillaries. The palatine surface near the end of the beak pre-

sents a number of small grooves extending forward from neuro-vascular canals within the maxillaries.

The nasal passages present the usual want of exact symmetry, and are in no wise peculiar. The right one measures an inch and three-fourths transversely, and the left one has a little greater fore and aft diameter. The nasal partition obliquely measures four and a half inches in depth.

The length of the beak in its entire condition, from the upper nares, has been about twenty-two inches. The perpendicular depth, from the posterior expanded extremity of the intermaxillary ridge to the lowest part of the median palatine carina, is four and three-quarter inches. The width of the beak, on a line with the anterior wall of the nasal passages and just outside the prenasal fossæ, is six and a half inches.

A section of the anterior extremity of the beak, across the exposed supra-vomerine canal, is transversely oval, with the left pole flattened and the upper part deeply notched, with the edges of the notch projecting upward. On each side of the notch there is a foramen directed from a canal extending parallel with the vomer, but situated between the maxillaries and the intermaxillaries.

CHONEZIPHIUS LIOPS.

Choneziphius leiops, Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 81.

A second and smaller species of Ziphioid Cetaceans, which may be regarded as of the same genus as the former, is indicated by another specimen from the same collection of fossils. It also consists of a muzzle detached from the cranium, and is represented in fig. 1, Pl. xxx. and fig. 2, Pl. xxxi. Like its associate, ascribed to *C. trachops*, it is exceedingly dense and has all the constituent bones completely co-ossified. Both specimens are brown in hue from ferruginous infiltration, but the one under special consideration is darker, and on freshly fractured surfaces appears black. Its upper part exhibits many holes produced by boring mollusks. The end of the beak is lost, but the specimen retains its supra-orbital processes.

From the ant-orbital notches the muzzle tapers, at first in a curving and then in a straight line, towards the end more abruptly than in the former species, so that the beak did not appear proportionately so long and narrow as in that one.

The co-ossified intermaxillaries cover the supra-vomerine canal except at the fore part of the beak, where it is exposed as a demi-cylindroid groove bounded by acute borders. How much the exposure of the canal is due to loss of a portion of the intermaxillaries, cannot be determined; but if the sharp edges of the groove are the natural condition, the loss has been small.

The supra-vomerine canal is cylindroid, slightly compressed laterally, and is about five-eighths of an inch in vertical diameter and half an inch transversely.

The conjoined intermaxillaries, where they cover the supra-vomerine canal, form an acute ridge expanding posteriorly in a long narrow triangular elevation with an irregularly rounded base bent unsymmetrically towards the left, and producing a central prominence to the prenarial or interorbital region. From the fore part of the intermaxillary eminence the sides of the rostrum slope forward and outward nearly evenly to the lateral borders of the beak. From the posterior expanded extremity of the intermaxillary eminence a groove extends to the nasal orifices, separating the prenarial fossæ. These have the same form as in *C. trachops*, and in the same manner converge forward into grooves extending along the beak, but in the fossil under consideration the grooves unite across the acute fore part of the intermaxillary ridge, about eight inches in advance of the nares. The grooves in their course, as in *C. trachops*, communicate with a large foramen continuous with a canal extending into the intermaxillary bone. The right prenarial fossa is larger and deeper than the left one, being about three and a quarter inches wide, while the latter is about two inches wide. The groove from the left fossa is partially overhung by the expanded base of the intermaxillary eminence.

Outside of the position of the prenarial fossæ the supra-frontal expansions of the maxillaries present another pair of deep curved fossæ, which converge forward and disappear upon the sloping sides of the beak. The left supra-orbital fossa is both deeper and wider than the right one. In front and behind, a pair of strongly marked vascular grooves, curving outwardly in opposite directions, communicate by a pair of foramina from the supra-orbital fossa, internally with the infra-orbital canal. Externally the supra-orbital fossæ are bounded by thick arched elevations of the maxillaries. The left supra-orbital eminence is conspicuously larger than the right one. The anterior orbital notches are wide, but shallow.

The lateral subacute border of the rostrum continues undivided to the anterior broken end of the beak. Near the middle of its course a vasculo-neural canal opens into a groove proceeding forward. On the left side, the lateral border of the rostrum bifurcates in advance of its middle into a pair of branches which extend forward widely separated. A vasculo-neural canal corresponding with that just mentioned, opens in the crotch of the dividing border.

The under part of the rostrum resembles in its construction the same part in *C. trachops*, but proportionately is more expanded posteriorly. From the posterior carina, separating the palatine articulating surfaces, a slight median ridge or line advances on the beak and disappears. No other mark than this line exists indicating the original separation of the maxillaries.

Just behind the palatine articular impression externally is seen the usual open part of the infra-orbital canal with its branches extending to the supra-orbital fossa.

The nasal passages present the same character as in *C. trachops*. The right one appears to have been slightly the wider, while the left appears to have had a greater fore-and-aft extent.

The length of the fossil in its present condition is a little over a foot from the anterior nasal orifices. When entire it has been about fourteen inches long. The breadth at the supra-orbital eminences is about eleven and a quarter inches. The depth of the base of the rostrum from the expanded extremity of the intermaxillary ridge to the palatine carina, is three and seven-eighths inches.

EBOROZIPHIUS.

EBOROZIPHIUS CÆLOPS.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 81.

Another specimen from the Ashley River collection of fossils belonging to the Pacific Guano Co., represented in fig. 5, Pl. xxx., and fig. 3, Pl. xxxi., likewise consists of the detached muzzle of a Ziphioid Cetacean apparently pertaining to a genus different from the foregoing and others previously described. It possesses the same ivory-like density of the preceding specimens, and as in them, all the constituent bones are completely co-ossified. Unlike the others, it is white on the surface, with pale brown in freshly fractured places. The specimen has lost the supra-orbital processes of the maxillaries, and the end of the beak for several inches is otherwise mutilated and considerably water-worn. In its present condition it is fifteen and a half inches in length. It pertained to an animal about the size of *Choneziphius trachops*, but the muzzle appears to have been less narrowed in front.

The inferior or palatine part of the specimen presents nothing strikingly different from that of the preceding specimens, referred to *Choneziphius trachops* and *C. liops*, but the upper part is sufficiently peculiar to have led me to ascribe the fossil to a different genus with the name above given.

The intermediate portion of the rostrum above forms a wide gutter, bounded on each side by a thick elevated tuberosity nearly occupying the position of the conspicuous rugged tract of the maxillaries of *Choneziphius trachops*. The maxillary tuberosity on the inner side is convex from behind forward. Its upper surface, slightly concave, slopes from a curved acute ridge, defining it from the inner side, forward and outward to the lateral acute border of the rostrum. In front, the tuberosity subsides and is continuous with a slight ridge advancing upon the

beak a short distance internally to its lateral border. Behind, an acute ridge descends from the highest point of the tuberosity and curves outward and backward towards the position of the supra-orbital roof.

The two maxillary tubercles are not quite symmetrical in size, shape, or position. The right one appears to have been rather the higher, and it extends further back than the left one, but not so far forward. Behind the tubercles, the wide hollow of the muzzle turns outwardly into a deep groove directed towards the position of the supra-orbital roof. Opening into the groove is a large foramen continuous with the anterior division of the infra-orbital canal, which opens behind on the fractured border of the fossil.

The broad deep hollow of the upper part of the muzzle is but feebly divided by the conjunction of the intermaxillaries. These form no conspicuous rising above the supra-vomerine canal such as exists in *Choneziphius*. Posteriorly, in the prenarial region, the intermaxillaries are separated by a deep notch or wide fissure terminating forward and communicating below with the back portion of the supra-vomerine canal. The latter anteriorly is exposed for more than half its length by the destruction of the upper fore part of the intermaxillaries. The canal is elliptical in transverse section with subacute poles, and is about an inch from above downward, and five-eighths of an inch transversely.

Outside the position of the vomer, in the specimen, on each side portions of a vasculo-neural canal are exposed by the breaking away of the intermaxillaries which in the complete condition covered them.

The position of the right prenarial fossa, as presented in the two species of *Choneziphius* above described, in the fossil under consideration, is occupied by a thick discoid plate, with an uneven surface, which reminds one of an exostosis.

The left prenarial fossa is concave and not occupied in the manner of the right fossa. It looks as if it had been dispossessed of a similar protuberance, though no traces of fractures are visible indicating the actual existence of such a plate.

The lateral margins of the rostrum posteriorly, converging from the position of the supra-orbital processes, are acute. Anteriorly, in the specimen, they are mutilated, but they exhibit evidences of having divided into a pair of less prominent ridges proceeding forward towards the end of the beak. The wide, shallow, concave surface between the ridges presents a vascular groove proceeding forward from a canal in the maxillary bone.

The estimated length of the muzzle from the nares is about twenty inches. The depth or thickness of the base, just in front of the prenarial fossæ, is about

three and a half inches. The width between the outlets of the anterior branches of the infra-orbital canals in the supra-orbital fossæ is nearly six inches.

In the broad deep hollow of the upper back part of the rostrum bounded by the stout maxillary crests, the fossil bears a striking resemblance to the corresponding part of *Hyperoodon*. In this, however, the intermaxillaries remain distinct in the median line, and neither of them exhibits the curious exostosis-like development of the right prenarial fossa. Further, in *Hyperoodon* the high lateral maxillary crests are crescentoid in an opposite direction—that is to say, they have their convexity outward instead of inward.

DIOPLODON.

DIOPLODON PROROPS.

Belemnziphius prorops, Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 81.

The beak of a Ziphioid Cetacean, represented in figures 3, 4, Pl. xxx., from the Ashley River phosphate beds, was presented to the Academy by Mr. C. S. Bement. It indicates a fourth species of a genus, differing from the preceding; and pertained to a smaller animal than any of the others. The specimen has the same ivory-like density and is of a ferruginous brown hue. All the constituent bones are co-ossified, as in the previous specimens, and in addition, the mesethmoid cartilage is ossified and fused with the surrounding bones, so that the beak is solid throughout and exhibits no trace of a supra-vomerine canal, except perhaps at the back part of the fossil. In the complete solidity of the rostrum it accords with the character in this respect of the genus *Dioplodon* of Gervais, or the *Belemnziphius* of Huxley.

The specimen in its present condition, in the median line, is about eight inches in length, and apparently less than an inch has been lost from the point. Viewed from above, fig. 3, the outline forms an isosceles triangle with the sides curving inwardly, but bulging a little near the apex. Viewed laterally, fig. 4, the upper outline from the root forward appears convex with an irregular deflection from the middle to the tip of the beak. Underneath, the line from the root forward presents a series of three concavities successively diminishing in length and depth. The conjunctions of the concavities form intermediate points, of which the posterior one is the more prominent and occupies a central position of the rostrum.

The upper part of the rostrum forms a median ridge from which the surface slopes off to the lateral borders. The ridge is formed by the union of the intermaxillaries, but it exhibits no trace of their original separation. The back part

of the ridge is the more prominent and thick, and is convex and smooth. Its anterior part is as it were cut away on each side, leaving a narrower median extension forward. At the back part of the rostrum the intermaxillary ridge verges on a wide shallow notch, communicating posteriorly and beneath with a deep fossa. The latter appears to be an unoccupied portion of the usual supra-vomerine canal. It widens in a triangular manner below to the broken floor of the vomer, and on each side is bounded by a broken ridge which appears to be the downward extension of the intermaxillary. Four pits, apparently the commencement of vascular canals, are directed forward from the fossa into the rostrum. Two of the pits form a pair below, the others are placed in the median line above the former.

On each side of the upper back part of the rostrum there is a foramen communicating with a vasculo-neural canal directed downward and forward within the intermaxillary bone. The two foramina are an inch and three-eighths apart.

The right lateral margin of the rostrum is acute. The left margin is obtuse and subsides forward. Above the margins a foramen opens from a canal directed forward in a groove. The foramen on the right is an inch and three-eighths behind that of the left side.

The inferior surface of the rostrum presents three pairs of concave facets separated by a median carina which is produced into a central prominence. The pairs of facets successively decrease and become more shallow from behind forward. The posterior largest pair appear to be the palatine articular surfaces. Vascular foramina and grooves leading from them are seen in various positions of the under surface of the rostrum.

At the posterior broken border of the specimen a large foramen is observed communicating with a canal directed inward and forward within the maxillary bone.

The estimated length of the beak in its entire state from the nasal notch is eight and a half inches. The depth or thickness at the notch back of the intermaxillary ridge is an inch and seven-eighths. The distance between the most prominent portion of the intermaxillary ridge and the central eminence of the palatine carina is two and a half inches.

PROROZIPHIUS.

PROROZIPHIUS MACROPS.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 87.

Since writing the preceding account, and presenting at a meeting of the Academy a notice of the remains referred to four species of Ziphioid Cetaceans, I have

met with another specimen indicating a fifth member of the same family. In a visit to the Centennial International Exhibition, in one of the cases belonging to the Smithsonian Institution, among a collection of fossils from the Ashley River phosphate beds, I observed the specimen to which I allude. Having made application for its use, it was at once obligingly loaned to me by Mr. W. P. Blake, the gentleman in charge.

The specimen, represented in figs. 1, 2, Pl. xxxii., like the foregoing, consists of the detached rostrum in advance of the nares, but is better preserved at the point. In the present condition it is about two feet in length; and it indicates an animal not only larger than any of those to which the other specimens pertained, but with the exception of the *Hyperoodon*, one of the largest of its kind. The bones of which it is composed are completely co-ossified, so as to leave barely a trace of their original separation, and the specimen is of the usual ivory-like density. The supra-vomerine canal is open throughout, but is exposed only for a few inches at the end.

The beak is long and narrow, with the sides more nearly parallel than in the previously described specimens. The basal half is prismoid with the upper surface remarkably flat, while the anterior half assumes a more conical form. No crest extends along the middle above as in the two rostra referred to *Choneziphius*, nor is there any trace visible of a median groove indicating the original separation of the intermaxillaries.

The lateral borders of the beak posteriorly form a subacute ridge defining the upper nearly flat surface from the inclined palatine surfaces beneath. The ridge extends further forward on the right than on the left, and finally subsides at the conical anterior end of the beak. At the termination of the left ridge there are two foramina, near together, the exit of neuro-vascular canals which open forward into grooves extending anteriorly. On the right there are two corresponding foramina, but one is situated on the lateral ridge several inches behind the other.

The prenarial fossæ appear to have resembled those of *Choneziphius*, being spoon-shaped concavities extending forward into grooves which end in canals penetrating to the interior of the beak.

The left prenarial fossa together with its grooved extension, is longer than the right and wider one. Externally it is defined, by a crescentic ridge, from the supra-orbital fossa. Internally it was separated from the right prenarial fossa by a deep wedge-shaped notch communicating below with the posterior extremity of the supra-vomerine canal.

The prenarial fossæ and the grooves proceeding forward from them define an

unsymmetrical expansion like that of the posterior part of the intermaxillary crest in the rostra attributed to *Choneziphius*. The surface of this expansion is depressed except where it contracts into the ridges bounding the anterior nasal notch.

The end of the beak exhibits on the right side a series of four foramina, the exit of neuro-vascular canals for the passage of maxillary vessels and nerves to the lip and gum. On the left side there are only two of the same kind of foramina.

The supra-vomerine canal where exposed at the end of the beak is ovate in section, acute below and obtuse above. It is over an inch vertically, and about five-eighths of an inch in width.

In the upper view of the beak, fig. 1, the sides at first converge in a curvilinear manner from the preorbital notches, then extend nearly parallel forward to about the middle, when they converge to the rounded point. At the middle, the beak is actually slightly wider than it is some distance back of this position.

In the lateral view of the specimen, fig. 2, at the upper part of the beak, the median line of the base barely projects above the lateral subacute border, and only becomes more prominent as the acute ridge formed by the lateral border descends forward and disappears. The inferior outline proceeds nearly straight forward in advance of the middle and then curves upward to the end of the beak.

The palatine surface posteriorly slopes on each side to a prominent acute carina largely formed by a triangular projection of the vomer. In advance of this it slopes from a median convex ridge, and in front is linguiform.

The rostrum at its middle is $4\frac{3}{16}$ inches wide and $3\frac{3}{8}$ deep; at its anterior fourth is $3\frac{1}{8}$ wide and 3 deep; at its posterior three-fourths is $4\frac{1}{4}$ wide and about $3\frac{1}{2}$ deep.

PROROZIPHIUS CHONOPS.

Another specimen of the beak of a Ziphioid Cetacean, which I observed among a collection of other fossils and phosphatic materials, on exhibition in the Agricultural Department of the Government, from the Ashley beds, worked by the Wando Mining Company, was kindly loaned to me by Mr. H. Amidon.

The beak represented in figs. 3, 4, Pl. xxxii., indicates a species different from any of the foregoing, but appears to be sufficiently like that of *Proroziphius macrops* to belong to the same genus. It has nearly the same form as the specimen ascribed to the latter, but is about one-fourth less in length and is proportionately broader. As in all the other beaks described, the constituent bones are completely co-ossified, while from the non-ossification of the mesethmoid cartilage the supra-vomerine canal remains open and is exposed for about three inches at the end of the beak.

The anterior extremity, comprising nearly half the length of the beak, is conical,

as in *Proroziphius macrops*, but is more prominent above just behind the position of the supra-vomerine canal. In the specimen this portion of the beak exhibits a remarkably eroded appearance, due to the tunnelling of boring mollusks. One of the tunnels makes a communication with the supra-vomerine canal just back of its exposed portion.

The back portion of the beak, in advance of the interorbital region is triangularly prismoid nearly as in *Proroziphius macrops*, but the upper surface is not quite so even. Along the middle, over the position of the conjoined and completely co-ossified intermaxillaries, it is slightly depressed, the depression narrowing forward and ceasing at the median most prominent portion of the beak. On each side of the depressed surface a narrow vascular groove extends forward from a canal opening from the interior of the beak.

The sides of the beak are defined from the inclined palatine surface by a ridge becoming obsolete anteriorly. A pair of vascular grooves extend along the ridge, and beneath its position extending all the way to the end of the beak there is a narrow groove which looks as if it might be the homologue of the alveolar groove in the Porpoises. The trace of a similar groove is observable at the fore part of the beak of *P. macrops*, which would have escaped attention had its much better developed condition not been observed in this.

The right prenarial fossa, preserved in the specimen, is a deep, wide, half funnel-like concavity, not prolonged forward in a groove as in *Proroziphius macrops*, *Choneziphius*, and others, but at once converging into a canal penetrating the beak.

The expansion formed by the conjoined intermaxillaries between the prenarial fossæ does not become so narrowed in its extension backward to the nares as in *Proroziphius macrops*, nor is this extension cleft as in the latter. In *Proroziphius macrops* the cleft just alluded to communicates beneath with the back part of the supra-vomerine canal, but in the beak under description there is no such opening.

The supra-orbital fossa of the right side, as seen in the specimen, presents no special peculiarity.

The length of the beak in the median line from the narial partition to the end is nineteen inches. The width of the beak near the middle is three and one-half inches, and the depth or height in the same position has been about the same measurement.

CETERHINOPS.

CETERHINOPS LONGIFRONS.

A fragment of the skull of a Cetacean, from the Ashley River phosphate beds, in the collection of the Academy, represented in figure 7, Pl. xxxiv., one-half the

natural size, I suspect to belong to a *Squalodont* or to a nearly related genus. It is composed of portions of the frontal, ethmoid, vomer, maxillaries, and intermaxillaries all intimately co-ossified. The specimen is black, moderately heavy, and in several positions retains some portions of soft rock, in which the fossil was once imbedded, and on which are several casts of lamellibranchs, whose characters are too obscure to determine whether they are of miocene or earlier forms. Besides the fossil shells the specimen exhibits a number of attachments of recent barnacles and oysters, indicating that it had been exposed to the action of the present sea.

The specimen as preserved appears bilaterally symmetrical, except so far as the regularity has been disturbed by accident.

The back portion of the vomer exhibits a comparatively capacious groove for the mesethmoid cartilage. The mesethmoid bone forms a thick partition separating the blowholes, and ends in a stout tuberosity at the commencement of the supra-vomerine canal.

The forehead as formed by the frontal is remarkably long fore and aft compared with its usual condition in the Cetaceans. At the occipital boundary it forms a transversely concave line, and the sutural border of the frontal in this position, from the exterior to the cranial cavity, is about an inch in thickness. The fore and aft length of the forehead is two inches, its breadth between the infra-orbital fossæ scarcely $2\frac{1}{4}$ inches. The surface of the forehead is nearly flat, but slightly convex laterally and towards the fore part. The nasals appear to have articulated at the fore part of the frontal and have been detached and lost, though it may be that what I have considered to be the frontal may in part consist of the co-ossified nasals. If the latter view is true, I cannot determine the extent of the nasals as all traces of their outline have been obliterated. The premaxillaries in the specimen appear to have been destroyed so far as to leave the supra-vomerine canal widely exposed. Their posterior part is comparatively narrow where it bounds laterally the blow-holes, and ends in a point extending three-fourths the length of the forehead between the frontal and the expanded supra-orbital portion of the maxillary. Just within the position of the suture defining the premaxillary laterally from the maxillary, a narrow groove extends forward to the broken extremity of the fossil.

The supra-orbital fossæ appear to have been symmetrical, and exhibit nothing unusual. Prenarial fossæ on the premaxillaries can hardly be said to exist.

The under surface of the fossil exhibits the frontal roof of the cranial cavity, together with two holes broken through the ethmoid into the nasal passages. The

latter appear to be about of the same proportionate extent, direction, and symmetry as in the Porpoises.

The co-ossified maxillaries in advance of the lower orifices of the nasal passages form a strong convex prominence, sloping off anteriorly and laterally. No portion of the maxillaries in the specimen contains portions of alveoli for teeth.

EUPACHEMYS.

EUPACHEMYS OBTUSUS.

Remains of turtles are not unfrequent in the Ashley phosphate beds, usually consisting of fragments of the osseous shells, and mostly so small as to yield unsatisfactory results in the determination of the genera and species.

Fragments of the shell apparently of two species of land turtles, one of large size, are indicated and figured in Holmes' Postpliocene Fossils of South Carolina.

The museum of the Academy contains fragments of costal plates of a large species of turtle from the vicinity of Beaufort, S. C.

Prof. Holmes has submitted to my examination a specimen, probably pertaining to the same species as the latter, from the Ashley River, in the vicinity of Charleston. It consists of a marginal bone, represented in figures 4, 5, Pl. xxxiv., half the natural size. I have not had sufficient time and opportunity to determine positively the exact position of the bone in the carapace, but it appears to agree nearest with the eighth of the left side in an *Emys*. The bone is also sufficiently peculiar to have made me uncertain in determining the upper and under surfaces. What appears to me to be the upper surface, fig. 4, rises in a prominent fore and aft ridge just outside of the middle. The inner division of the surface is transversely concave; the outer forms a sloping plane to the external obtuse margin of the bone. The under surface transversely forms a single long convex sweep from the inner to the outer margin of the bone. Fore and aft it is feebly concave.

The posterior sutural surface, fig. 5, exhibits the outlines of the upper and under surfaces.

The upper surface of the bone is not smooth, and is even rough and somewhat eroded on the outer division. It exhibits no distinct trace of grooves defining the position of scutes. The under surface of the bone is smooth, and exhibits near the inner border a fore and aft furrow, and near the middle a more feebly developed one, defining marginal scutes.

The length of the posterior sutural surface of the bone is a little over five inches; the thickness is three inches. The fore and aft extent of the upper surface is four and three-quarters inches.

The specimen I have referred to a species and genus with the name heading the present article.

TRIONYX.

I have repeatedly seen small fragments of the bony shell of species of *Trionyx*, from the Ashley deposits, but too small to determine from them any important specific character. Figure 3, Pl. xxxiv., represents a fragment of a costal plate, one-half the natural size, apparently an eocene fossil from Ashley River, presented to the Academy by Mr. C. S. Bement.

MYLIOBATES.

MYLIOBATES MAGISTER.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 86.

A specimen of the dental armature of an eagle ray, in the Ashley collection of fossils, indicates one of the largest of its kind. It is one-fourth larger than the specimen from the same locality described and figured by Gibbes under the name of *M. Holmesii*. It is not improbable that it may have pertained to a larger individual of the same species, and its other differences may be accounted for by supposing that it belonged to the opposite surface of the mouth. The original specimen ascribed to *M. Holmesii*, judging from its convex triturating surface, belonged to the roof of the mouth. The specimen under consideration may be supposed to have belonged to the floor of the mouth. It is imperfect at the extremities and lateral borders. Represented in figure 7, Pl. xxxiii., the fore part is deeply worn in evidence of the service performed by the organ in comminuting hard food. The unworn surface is smooth, and is transversely convex, but slightly depressed along the middle. Fore and aft it is in a less degree convex.

The breadth of the median teeth is three and three-quarter inches, and five of these teeth unworn occupy an antero-posterior extent of two and a half inches. The sutural lines of the median teeth are slightly convex backward in the middle and more strongly convex forward at the sides.

The sutural lines of the median teeth are much less curved than is represented to be the case in the specimen ascribed to *M. Holmesii*, but perhaps this difference would exist between the upper and lower dental pavements of the species.

The under or attached surface of the plate is too much broken away to determine the greatest thickness of the pavement.

The specimen referred to *M. magister* is about as large as that of *M. Dixoni*,

Ag., from the eocene formation of Bracklesham, as represented in figure 14, Pl. xi., of Dixon's Geology of Sussex, England. The median teeth of the former are proportionately not so wide fore and aft as in the latter.

MYLIOBATES MORDAX.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 86.

Several specimens of the dental armature of Rays from the Ashley phosphate beds, which have come under my observation, appear to indicate a species distinct from the former, and also from *M. Holmesii* as characterized by the specimen described by Dr. Gibbes.

Two of the specimens pertain to the collection submitted to my examination by Mr. J. M. Gliddon. One of them, represented in figure 1, Pl. xxxiii., is an inferior dental plate, and consists of the greater portion of nine median teeth together with part of the first row of small teeth on one side.

The triturating surface for the most part, nearly flat, is feebly curved fore and aft, but is more convex transversely, and becomes more so approaching the lateral borders. The surfaces of the median teeth successively incline slightly backward, so that their anterior margins are decidedly elevated above the contiguous margins of the teeth in advance. This arrangement produces an unusually uneven transversely ridged surface like that often observed on the surface of an ordinary rasp. The transverse sutures of the median teeth are nearly straight except at their extremities where they curve backward. Feeble ridges, not laterally symmetrical and interrupted by the prominent anterior margins of the median teeth, extend along the dental pavement.

The under surface of the dental plate slopes evenly from the median line to the lateral borders. At the middle, the dental plate, including the root, is ten lines thick. On the triturating surface, seven median teeth occupy an extent fore and aft of 28 lines. The first of this series measures in the same direction $3\frac{1}{2}$ lines; the last of the series, 4 lines. The breadth of the median teeth in their perfect condition has been about 38 lines.

From the dental plate of *Myliobates Holmesii*, from the same locality, as represented by Dr. Gibbes (Journ. Acad. Nat. Sc., 1850, Pl. xlii., fig. 1), the specimen just described differs in a number of points. While it has nearly the same breadth and thickness, thus indicating fishes of about the same size, the triturating surface is decidedly less convex transversely, the median teeth are proportionately of less width, and the transverse sutures are comparatively straight.

In addition, the triturating surface of the plate of *M. Holmesii*, if one can form a correct idea of it from the figure, appears even, as is usually the case, instead of being transversely ridged, from the successive inclination of the median plates, as in the specimen described.

The second of the two specimens, above referred to, is likewise a dental pavement from the floor of the mouth, and is represented in figure 2, Pl. xxxiii. It is composed of ten median teeth, and some of those of the first lateral row of small ones on both sides. The dental plate has about the same form as the preceding, but is of less breadth and much thinner, and, therefore, at least may be inferred to have belonged to a smaller individual. The triturating surface is feebly depressed along the middle, but has the same uneven character, though in a less degree, due to the slight elevation of the anterior borders of the median teeth, and the successive slight inclination of their surfaces. The transverse sutures are less straight than in the former specimen, especially the more posterior ones, which appear slightly bent forward, and also appear more open or wider.

On the triturating surface seven median teeth occupy an extent equal to the same number in the preceding specimen. The first and last of the series measure $4\frac{1}{4}$ lines. The breadth of the median teeth is about 30 lines. The thickness of the dental plate in the middle is $7\frac{1}{2}$ lines.

The inferior surface of the base of attachment slopes off from the median line with a slight inflection.

Another specimen, represented in figure 3, Pl. xxxiii., which may probably belong to the same species as the foregoing, is a superior dental plate, and was recently presented to the Academy by Mr. George S. Lewis. Its upper or attaching surface has adherent a quantity of calcareous rock, like that of the eocene marl rock, which underlies the Ashley phosphate beds. This serves to confirm the information derived from Prof. F. S. Holmes, that the specimen and others similar are eocene fossils.

The dental pavement consists of about a dozen median teeth together with part of the contiguous two rows of lateral teeth at the sides. The triturating surface is well arched fore and aft, and is also in a less degree convex transversely. The median teeth and intervening sutures are nearly straight transversely, but curve backward at the extreme ends. The conjoined edges of the median teeth are slightly prominent, giving the transversely ridged appearance more obvious in the preceding specimens of the floor of the mouth. Feeble ridges extend the length of the triturating surface.

The lateral teeth extend the convexity of the sides of the triturating surface.

The length of the specimen in its present condition is three inches five lines; its breadth three inches. Seven median teeth occupy an extent fore and aft of $25\frac{1}{2}$ lines, or $2\frac{1}{2}$ lines less than in the preceding specimens. The median teeth are 32 lines in breadth, and 4 lines fore and aft.

MYLIOBATES OBESUS.

Leidy: Proceedings Academy Natural Sciences, 1855, 396.

Myliobates rugosus, Leidy: Ibidem, 395.

In the neighboring State of New Jersey, in excavating the green sand marl, extensively employed as a fertilizer, many vertebrate fossils are found, mainly consisting of remains of reptiles and fishes. Three distinct marl beds are recognized alternating with beds of sand, clay, and limestone, all conformable with one another, and until recently all regarded as pertaining to the cretaceous period. Latterly, the lower two marl beds have been considered as of the cretaceous period, while the upper one has been viewed as belonging to the early tertiary or eocene period. Many fossils of the different marl beds have been presented to the Academy, and though having attached what is recorded as the name of the locality, this is usually that of the nearest town or village, while the particular bed from which they were obtained has been rarely designated. As a result we are frequently perplexed in attempting to ascertain the relative age of the fossils, which were once all ascribed to the cretaceous period, and which are now in part considered to belong to the eocene period.

Among the fossils of the marl beds presented to the Academy, there are many remains of fishes of which the teeth of sharks greatly predominate. The collection of the Academy contains a large and beautiful series of well-preserved teeth viewed as belonging to *Carcharodon angustidens** and *Otodus obliquus*. The greater number of these are from the neighborhood of Vincenttown, Burlington Co., N. J., presented by Col. T. M. Bryan. The two species were originally described by Agassiz, from teeth found in the tertiary deposits of Europe, and we may therefore suppose that the teeth from New Jersey ascribed to the same species were obtained from the upper or eocene marl bed.

Among the remains of fishes from the New Jersey marl beds there are also specimens of the dental armature of Eagle-rays, and as similar remains in Europe

* Gibbes (Journal A. N. S., 1847-50, p. 146) refers to some of the specimens as pertaining to another species with the name of *C. acutidens* founded on teeth from the eocene limestone of South Carolina. His views of these teeth (Pl. xxi., figs. 39-44), and such is also the case with the New Jersey teeth, are actually more like those of *C. angustidens*, as represented by Agassiz in the Poissons Fossiles, than those, likewise from the eocene of South Carolina, which Gibbes refers to the latter named species.

are alone ascribed to the tertiary formations, we may suppose that the New Jersey fossils belong to the upper or eocene marl bed.

A specimen formerly described under the name of *Myliobates rugosus*, represented in figure 10, Pl. xxxi., is from New Egypt, Ocean Co., and was presented to the Academy by T. A. Conrad. It consists of four unworn median teeth, the first and last with one extremity lost. The triturating surface is convex both fore and aft and transversely, and is wrinkled longitudinally to an unusual degree especially at the extremities of the teeth. The sutures of the median teeth curve backward, but are not deflected from this course at the ends.

The four teeth occupy an extent fore and aft of twenty lines. The first and second of the series measure $5\frac{1}{2}$ lines antero-posteriorly; the last one $4\frac{1}{4}$ lines. The second tooth is twenty-eight lines broad. The radical portions of the teeth are broken away, and the bases of the crowns are nearly straight transversely. The crown of the first tooth of the series is 5 lines thick at the middle, and it thins away to $1\frac{1}{4}$ lines at the ends.

A specimen represented in figures 8, 9, Pl. xxxi., from Vincenttown, presented to the Academy by Col. T. M. Bryan, consists of a pair of unworn median teeth. These sufficiently agree with the corresponding teeth of the preceding specimen to pertain to a smaller individual of the same species. They are highly polished on the free surface, and present scarcely any wrinkling except near the ends. The sutural borders transversely have almost the same extent of curvature as in the former specimen, and the triturating surface has nearly the same degree of convexity, but becomes rather more deflected at the ends so that the teeth are proportionately thicker in this position. The base of the crowns is straight, and the bottom of the root feebly slants from the middle laterally.

The two teeth measure fore and aft at the middle 8 lines, and in thickness $5\frac{1}{4}$ lines. The crown of the anterior tooth is 4 lines thick at the middle and 2 lines at the angular ends.

The specimen originally referred to *M. obesus*, figure 44, Pl. xxxiv., consists of two imperfect median teeth. It was found in the marl of Pemberton, Burlington Co., and was presented to the Academy by Dr. Charles H. Budd. The front tooth is worn, indicating the anterior position of the specimen in the dental series. The fore and aft extent of the two teeth is half an inch; the thickness is $4\frac{1}{4}$ lines.

An isolated median tooth from Mullica Hill, Gloucester Co., was presented to the Academy by Dr. Wm. B. Atkinson. It accords in form and size sufficiently well with the imperfect teeth of the specimen just indicated to belong to the same species, and to an individual of nearly the same size or age. The breadth of the

tooth is $18\frac{1}{2}$ lines; its thickness 4 lines. The width of the crown fore and aft is 3 lines; the thickness at the middle is $2\frac{1}{2}$ lines, and at the ends $1\frac{1}{2}$ lines.

Another isolated median tooth, represented in figures 6, 7, Pl. xxxi., is from the same locality and donor as the preceding specimen. With the exception of a slight unsymmetrical bend forward of one end, the tooth is straight, with the triturating surface transversely convex and even. The ends of the tooth are angular, and the bottom of the crown and the root are straight transversely. The breadth of the crown is 2 inches; its width fore and aft 5 lines; its thickness at the middle equals the width, and it diminishes to 3 lines at the ends. The tooth including the root is 7 lines thick at the middle.

The dental armature of *Myliobates obesus*, in the form and convexity of the median teeth, resembles that of *M. Dixoni*, Ag., from the eocene of Bracklesham, as represented in figures 1, 2, Tab. x., of Dixon's Geology of Sussex. The teeth in the latter appear generally to be of greater width fore and aft.

MYLIOBATES FASTIGIATUS.

Leidy: Proceedings Academy of Natural Sciences, Philadelphia, 1876, 86.

A specimen, represented in figure 6, Pl. xxxiii., of the dental armature of an eagle ray, differs from any which I have seen described, and may perhaps indicate a species different from any previously indicated. It is from Monmouth Co., N. J., probably from the "upper marl bed," or eocene green sand, and was presented to the Academy by William Cleborne.

From the arching form of the specimen it is to be viewed as having belonged to the roof of the mouth. It is composed of nine median teeth with the addition of some of the small teeth of the first row on each side. The fore part of the pavement extending to the third median tooth is much abraded from the attrition of food.

The pavement is well arched fore and aft, and in its present state measures three and one-third inches with a little less breadth. The triturating surface forms three longitudinal convex ridges, of which the intermediate one is the broader and more prominent. Broad shallow valleys separate the ridges, and the lateral ones of these include the small teeth.

The transverse median sutures curve backward on the median ridge and forward on the lateral ridges. The median teeth are three inches broad, and about five lines wide fore and aft. Their free surface is nearly even, but is feebly wrinkled in the valleys and upon the lateral ridges of the dental pavement.

The lateral hexagonal teeth are longer than broad, and each is impressed along the middle.

The upper surface of the dental pavement is concave fore and aft, and is convex or slopes off laterally from the median line. The thickness of the pavement on the median ridge is $9\frac{1}{4}$ lines; on the lateral ridges $5\frac{1}{2}$ lines.

Another specimen, represented in figure 11, Pl. xxxi., also from Monmouth Co., N. J., presented to the Academy by the late Dr. J. H. Slack, perhaps belongs to the same species as the preceding, though it exhibits some important differences. It is likewise an upper dental plate, and is worn away at the anterior part from the attrition of food. It retains seven median teeth, together with three small teeth of the first row of one side, and in its present condition measures two and a half inches long.

The pavement is considerably narrower in proportion with its length than in the former specimen, while the thickness in each is nearly the same. Seven median teeth in the first described plate measure together $31\frac{1}{2}$ lines by 35 lines in breadth; in the specimen under examination the same number of teeth measure $29\frac{1}{2}$ lines by 26 lines in breadth. The median convex ridge of the triturating surface is equally prominent, but the lateral elevations are nearly obsolete. The transverse sutures present but one flexure corresponding with the median one backward in the former specimen.

The median teeth range from $4\frac{1}{4}$ to $4\frac{3}{4}$ lines fore and aft. The thickness of the pavement on the median ridge is $8\frac{3}{4}$ lines; and at the sides $5\frac{1}{2}$ lines.

Prof. Marsh has noticed a specimen of a dental plate, in the Proceedings of the American Association for the Advancement of Science, 1869, from the eocene green sand of Monmouth Co., under the name of *Myliobates bisulcus*, to which one or other or perhaps both of the former may also belong. He remarks that it has "the central row of teeth marked along the median line by a deep groove. In other respects the dental surface is remarkably smooth and flat." These characters render it probable that it may be the inferior dental plate of the same species as that to which the former specimens pertain.

MYLIOBATES SERRATUS.

Leidy: Proceedings Academy Natural Sciences, 1855, 395.

This species was named on the specimen of a dental plate, represented in figure 5, Pl. xxxii., which was found in the marl of Pemberton, Burlington Co., N. J., and was presented to the Academy by Dr. Charles H. Budd. It resembles most the dental armature of *Myliobates toliapicus*, Ag., and *M. suturalis*, Ag.

The specimen consists of the greater part of six median teeth, and four of the first row of teeth on each side. The triturating surface of the plate is dull in aspect, flat, but slightly impressed along the median line, and inclines forward and inward on the first tooth, apparently as the result of wearing.

The transverse sutures of the median teeth are gently curved with the convexity backward. The lateral teeth are hexagonal, and nearly as broad as they are fore and aft wide.

The sutures generally, but especially the outer parts of the median transverse sutures and those uniting the median and lateral teeth, as well as these together, are remarkable for their unusually serrulate condition. The same character is remarked in *Myliobates suturalis*. The root surface of the specimen slopes strongly on each side from the median line. The width of the plate fore and aft of six teeth measures 10 lines; the breadth including the first lateral row of teeth is $12\frac{1}{4}$ lines. The breadth of the median teeth is 10 lines; the fore and aft extent of the fourth median tooth is 2 lines.

MYLIOBATES JUGOSUS.

Leidy: Proceedings Academy Natural Sciences, Philadelphia, 1876, 86.

An isolated median tooth, represented in figures 4, 5, Pl. xxxi., probably indicates a species of eagle ray different from the former. The specimen is likewise from the marl of Vincenttown, Burlington Co., N. J., and was recently presented to the Academy by Col. T. M. Bryan.

The tooth is transversely nearly straight, and the ends are angular and adapted to the articulation of small hexagonal teeth as in the species of *Myliobates* generally. The crown forms a thick median transversely convex prominence with the sides extended outwardly and thin. The prominence appears as an exaggeration of the median ridge of the dental plate of *M. fastigiatus* due to the more abrupt depression of the sides of the crown. The tooth at the median prominence is no thicker than in the smaller of the dental plates described under the name of *M. fastigiatus*, while it is considerably broader. The triturating surface is transversely convex on the median prominence and becomes nearly flat upon its reflected sides. The dull aspect of the triturating surface, and the comparatively thin condition of the sides of the crown probably indicate some reduction as the result of wearing. The anterior inclining surface of the crown and the projecting posterior surface indicate a somewhat imbricated arrangement of the median teeth. In the specimen the back of the eminence of the crown is unsymmetrical, apparently deformed. The base of the crown opposite the median eminence is concave, and this curvature at the sides is slightly deflected. The root is straight on its attaching surface.

The breadth of the tooth is nearly $2\frac{1}{2}$ inches; its median height $8\frac{3}{4}$ lines, and at the sides 4 lines. The width of the crown fore and aft is about 5 lines, and its thickness at the middle about the same, while at the sides it is but $1\frac{1}{2}$ lines.

MYLIOBATES GIGAS.

Cope: Proceedings Academy Natural Sciences, 1867, 140.

This species was first described and named by Prof. Cope from remains found in the miocene formation of Charles Co., Maryland. Of the specimens, presented to the Academy, the best is represented in figure 4, Plate xxxiii. It consists of a dental pavement, indicating by its strongly arched condition antero-posteriorly that it pertained to the roof of the mouth. It retains portions of thirteen median teeth, together with part of two rows of lateral teeth on one side, and of one row on the other side. In its present state it measures four inches in its extreme length. The fore part of the pavement including six median teeth is more than half broken away, while the remaining portion of the same teeth is much abraded from the attrition of food. The pavement is comparatively thin in proportion with its breadth. The triturating surface is convex transversely, and is more curved at the sides than across the middle. It is nearly even and smooth, and exhibits but feeble striation fore and aft. The median teeth and their intervening sutures are straight along the middle, but curve backward at the extremities. The posterior median teeth are wider fore and aft than the more anterior ones.

Two lateral rows of teeth appear to have completed the dental pavement at the sides. In the specimen the teeth of the inner lateral row are not symmetrical on the two sides, three on the right being longer than broad, while three of the left are nearly equal in the same directions. Their front and back sutures are the shortest, and slant outward and backward; the antero-internal and postero-external sutures are intermediate in length to the former and those opposite to them. The teeth of the outer row are convex along the external border, but more abruptly rounded posteriorly.

The upper or attached surface of the dental plate is feebly elevated at the lateral borders and middle.

The posterior seven median teeth, except the last one, occupy an extent of two and a half inches. The breadth of the median teeth is 3 in. $2\frac{1}{2}$ lines. The width fore and aft of the seventh median tooth is 4 lines; of the twelfth tooth, 5 lines. The thickness of the dental plate at the middle is $6\frac{1}{2}$ lines.

A fragment of a second specimen presents nearly identical characters, but is less even on the triturating surface due to the slight prominence of the anterior

portions and depression of the contiguous posterior portions of the median teeth as in *Myliobates mordax*.

MYLIOBATES VICOMICANUS.

Cope: Proceedings Academy Natural Sciences, 1867, 140.

The species thus named by Prof. Cope was based on specimens found in association with those attributed to *M. gigas*. The best preserved of the specimens represented in figure 5, Plate xxxiii., consists of an inferior dental pavement. It retains eleven median teeth, together with part of two lateral rows on one side, and of one row on the other side, and measures a little over three inches in length. The anterior three or four median teeth are abraded from the trituration of food.

The plate beneath is almost straight fore and aft, and is slightly convex in the same direction on the triturating surface. This is also moderately convex transversely, but is feebly depressed along the middle. The surface is comparatively even and smooth.

The median teeth and intervening sutures are nearly straight across the middle of the pavement, but present a feeble convexity backward, while the ends curve backward.

The lateral teeth have the same character as in the former specimen ascribed to *M. gigas*, and as in this, there appear to have been but two rows on each side.

Seven median teeth except the last in the specimen, measure together fore and aft $25\frac{1}{2}$ lines. The fifth tooth is $3\frac{3}{4}$ lines wide fore and aft, and the eighth one is 4 lines wide. The breadth of the median teeth is $27\frac{1}{2}$ lines.

The under surface of the dental plate slopes off on each side from the median line, where the plate is half an inch thick.

M. gigas has been characterized alone from the superior dental armature, and *M. vicomicanus* alone from the inferior dental armature. The characters of the two armatures are sufficiently alike to render it probable that they may pertain to the same species.

MYLIOBATES PACHYODON.

Cope: Proceedings Academy Natural Sciences, 1867, 140.

A third species of an eagle-ray was described by Prof. Cope, under the above name, from a fragment of a dental plate, represented in figure 6, Plate xxxii., which was found in association with the former in Charles Co., Md. The specimen retains portions of four median teeth together with portions of several of a lateral row, and in its present condition measures $1\frac{3}{4}$ inches long. It appears to

be a fragment of the inferior dental pavement, and at its fore part is worn from the attrition of food. It is especially remarkable for its thickness in relation with its breadth; the crowns of the teeth at the middle of the plate being $7\frac{3}{4}$ lines thick, and thin away to a sharp edge at the lateral border, in a distance of an inch and a quarter.

The triturating surface is transversely convex and even. The median teeth with their intermediate sutures are nearly straight, and curve backward but slightly at their outer extremities.

Apparent traces of a second row of small teeth are seen in the specimen external to the more conspicuous teeth of the first row.

The intermediate two median teeth of the specimen measure each fore and aft 5 lines. The breadth of the median teeth in a complete condition appears to have been about $2\frac{1}{2}$ inches. The thickness of the dental plate in the middle is 10 lines. The inferior surface slopes with a slight inflection from the middle to the lateral border.

In the proportionate thickness and breadth of the dental plate and the convexity of the triturating surface, it resembles that of *Myliobates Holmesii*, but the median teeth and transverse sutures differ in their comparative straight course.

MYLIOBATES.

Several fragments of dental plates, found with the preceding in Charles Co., Md., may perhaps pertain to another species. One of the specimens, represented in figure 7, Pl. xxxii., consists of a portion from the back part of an inferior dental pavement, comprising five median teeth with portions of one contiguous lateral row. The triturating surface is nearly flat, being slightly convex transversely fore and aft. The median teeth and their intervening sutures are more straight than in any of the specimens previously described, except that referred to *M. serratus*. The transverse sutures, though generally nearly straight, are slightly irregular in their course. In the specimen the first one bends a little forward towards the middle; the second is the straightest of the series; the third and fourth are nearly like the first.

The inferior surface of the dental pavement slopes gently from the median line towards the lateral borders.

Thickness of the pavement at the middle 5 lines; probable breadth when entire about $2\frac{1}{2}$ inches. Breadth of median teeth when entire about 28 lines; fore and aft width of the same ranging from 4 to 5 lines.

Another specimen is a fragment from the anterior worn part of a dental pavement, comprising portions of four median teeth with the contiguous two rows of smaller ones of one side. The triturating surface is worn concavely forward, and is convex on the position of the small teeth. The median teeth and intervening transverse sutures are as straight as in the former specimen, but the teeth are not so wide fore and aft. The lateral teeth of the specimen apparently indicate two rows to render the sides of the plate complete.

MESOBATIS EXIMIUS.

Ætobatis eximius, Leidy: Proceedings Academy Natural Sciences, 1855, 396.

This species was originally indicated from the specimen represented in figure 12, Plate xxxi. It was obtained by the late Capt. A. H. Bowman, from the sands of Ashley River, S. C., and is supposed to have been derived from the eocene formation. The specimen consists of little more than half of four median teeth with the lateral teeth. The triturating surface is nearly flat, but rounded at the border, and is feebly wrinkled longitudinally. The transverse sutures the greater part of their course are nearly straight, but curve backward approaching the ends, and they exhibit the slightest posterior inflection at the middle.

The lateral teeth formed but a single row, occupying the angular notches between the ends of the median teeth. Their outer border is fore and aft convex. The bottom of the roots forms a flat surface slightly sloping from the median line. The estimated breadth of the dental pavement is scarcely two inches; the fore and aft extent of the four median teeth is thirteen lines. The breadth of the median teeth is 22 lines; the fore and aft width, $3\frac{1}{3}$ lines; the thickness at the middle, 4 lines. The crowns are $2\frac{3}{4}$ lines thick at the middle and thin outwardly to nothing at the angular ends. The lateral teeth are 3 lines long and $1\frac{1}{4}$ lines broad.

ÆTOBATIS PERSPICUUS.

Leidy: Proceedings Academy Natural Sciences, 1855, 396.

This species was first indicated in 1855, by the fragment of a tooth represented in figure 13, Plate xxxi. The specimen was found in Monmouth Co., New Jersey, and was presented to the Academy by Dr. J. L. Burtt. No other specimen which can be attributed to the same species has been brought to my notice. Though considered to belong to the upper dental pavement, I am not satisfied that such is its correct position. Taking, however, this view of it, the transverse borders extend relatively further forward than in the recent *Ætobatis narinari*.

The triturating surface is flat, and the end only slightly rounded. The enamel-

loid layer turns abruptly upward at the end of the tooth for about one line. The anterior border of the tooth is angularly convex the greater part of its extent, but is feebly deflected in the opposite direction laterally. At the end it presents a projection adapted to a crescentoid depression or socket of the contiguous tooth. The posterior border, corresponding in its course with the anterior, presents a narrow flange along the greater part of its length, and a crescentoid socket at the end of the tooth, adapted to receive the projecting border of the contiguous tooth. The thickness of the tooth at the middle is four lines, from which it thins off to $2\frac{1}{2}$ lines just within the rounded lateral border. The breadth of the tooth has been about $2\frac{1}{4}$ inches; the width fore and aft is four lines.

The tooth is nearly like the corresponding ones of *Ætobatis irregularis*, Ag., from the eocene of Bracklesham, as represented in figure 7, tab. x., and figures 2-4, tab. xi. of Dixon's Geology of Sussex, England. It bears much less likeness to those of the specimen ascribed to the same species and represented in figure 3, tab. 47 of the Poissons Fossiles.

ÆTOBATIS ARCUATUS.

Agassiz: Poissons Fossiles. Gervais: Paléontologie Française, Pl. 80, 1-3. Cope: Proceedings Academy Natural Sciences, 1867, 139.

Numerous isolated teeth from the miocene formation of Charles River, Maryland, have been referred by Professor Cope to the above-named species, originally described by Agassiz from specimens found in the miocene formation of Switzerland.

The teeth, generally worn and in fragments, sometimes vary so much as to render it uncertain whether to consider them as belonging to the upper or lower series. They resemble in form those of the living *Ætobatis narinari*, but, unless the difference is due to wearing, they appear to have proportionately thinner crowns and longer roots.

Figure 14, Plate xxxi., represents the left half of an inferior tooth. Its triturating surface is flat and slightly wider at the ends than at the middle. The front and back borders are nearly parallel but slightly inflected, and are oblique at an angle of about 45° . The outer end is rounded off rather more abruptly than in *A. narinari*. The breadth of the fragment obliquely is $1\frac{1}{2}$ inches; the width ranges from $2\frac{3}{4}$ to $3\frac{1}{2}$ lines. The length of the root internally is half an inch.

Figure 15 represents the median portion of an inferior tooth. The triturating surface is wider than in the preceding specimen, and the angle formed by the conjunction of the two sides is more prominent forward than it would appear to have

been in the other tooth. The width of the crown fore and aft at the middle is $4\frac{1}{2}$ lines; the length of the root is half an inch.

Figure 16 represents an inferior tooth with the extremity of the left side lost. The median portion is unsymmetrical, on the right appearing to be more abruptly produced forward than on the left. The side of the tooth narrows rapidly from the median line outwardly. The breadth of one side of the crown is about $1\frac{1}{2}$ inches; the width at the middle is $4\frac{1}{2}$ lines, and at the outer end $2\frac{1}{4}$ lines. The length of the root is half an inch. The breadth of the dental plate, estimated from this specimen, would be about two inches and a third.

Figure 17 represents the right portion of a superior tooth. The triturating surface is flat at the middle, but slightly convex laterally. The front and back borders are less oblique than in the lower teeth, forming an angle of nearly 10° less. At the middle the same borders are less angularly curved; and the front border at its outer end is more deflected forward. The breadth of one side of the crown is about 16 lines; the width of the triturating surface at the middle is $3\frac{3}{4}$ lines; near the outer end where narrowest, $2\frac{1}{2}$ lines. The length of the root is about five lines.

Figure 18 represents a fragment from the left side apparently of an upper tooth. The triturating surface has a greater width than in the preceding specimen, especially towards the middle. The lateral borders appear more oblique and more abruptly deflected inwardly to the middle than in the former. Width of the triturating surface fore and aft at the middle, $5\frac{1}{2}$ lines; at the side, $2\frac{3}{4}$ lines. Length of the root, 9 lines.

Perhaps this specimen may pertain to a different species from the preceding.

ÆTOBATIS PROFUNDUS.

Cope: Proceedings Academy Natural Sciences, 1867, 139.

Isolated specimens of teeth, mingled with those above described, Professor Cope has referred to a distinct species with the name of *A. profundus*. They appear to me to be only the most anterior and worn teeth of the same species as those referred to *A. arcuatus*, as similar differences are observed between the corresponding teeth of the recent *A. narinari*.

Figure 19, Plate xxxi., represents an anterior tooth of the lower dental series. The two sides of the crown meet at an obtuse rounded angle forward, and the triturating surface is worn off in a convex manner anteriorly. The ends of the crown also appear to be worn off. The breadth of the crown is 17 lines; the width fore and aft at the middle is $2\frac{1}{2}$ lines. The length of the root is about five lines.

Figure 20 represents the left portion of a similar tooth of a larger individual, presenting the same characters as the preceding specimen. The breadth of the right side of the crown is 17 lines; its width at middle, $2\frac{3}{4}$ lines. The length of the root is 5 lines. The breadth of the dental plate estimated from this tooth fragment, is about two inches.

ZYGOBATES DUBIUS.

Leidy: Proceedings Academy Natural Sciences, 1855, 396.

A species of eagle ray, with the dental organs tessellated in the manner of the recent *Zygobates Jussieu*, was formerly indicated under the above name from a number of isolated teeth, obtained from the Ashley River deposits by Capt. A. H. Bowman. Similar isolated teeth are occasionally noticed among the collections of fossils from the more recent explorations of the phosphate beds of the same locality.

Figures 21-37, Plate xxxi., represent teeth of the kind to which we allude.

A median unworn tooth, represented in figures 21, 22, in form and size is nearly like the more posterior unworn median teeth of the living *Zygobates Jussieu*. It is straight transversely, but slightly bent, so that the triturating surface is a little concave from side to side. The triturating surface is feebly convex fore and aft, highly polished, and slightly wrinkled longitudinally. The breadth of the crown between the rectangular ends is an inch and a half; the width fore and aft one fourth of an inch, and the thickness both at the middle and sides is three and a quarter lines. The root of the tooth is lost.

A second specimen of a median unworn tooth, represented in figure 23, resembles the preceding, but is not bent in the same manner. Its measurements are as follow: breadth, $13\frac{1}{2}$ lines; width, $2\frac{3}{4}$ lines; thickness, $4\frac{1}{2}$ lines; thickness of crown, $3\frac{3}{4}$ lines.

A third specimen represented in figures 24, 25, is different enough in character to pertain to another species. In its greater proportionate width fore and aft, in the dull aspect and evenness of its triturating surface, and in the comparative thinness of its crown, it resembles the more anterior worn teeth of the existing *Zygobates Jussieu* in relation with the posterior unworn teeth. It is well arched with the triturating surface convex transversely, instead of being nearly flat or slightly concave as in the former specimens. Its measurements are as follow: breadth, 16 lines; fore and aft width, 4 lines; thickness, 3 lines; thickness of the crown, 2 lines.

A fourth specimen, represented in figures 26, 27, is like the last, but is of much less width fore and aft. Its measurements are as follow: breadth, 16 lines; fore

and aft width, 3 lines; thickness, $3\frac{1}{4}$ lines; thickness of crown, $2\frac{1}{4}$ lines. The differences from the former are such as are observed in intermediate teeth to the worn and unworn teeth of the recent *Zygobates Jussieu*.

Figures 28–33 represent three teeth, which from the difference in thickness between their outer and inner ends, indicate a position in the series succeeding the median one. The dull aspect of the triturating surface and the comparative thinness of the crown show that they are all worn specimens. Their measurements are as follow:—

Breadth of crown . . .	$12\frac{1}{2}$ lines.	11 lines.	$10\frac{1}{2}$ lines.
Width fore and aft . . .	$4\frac{1}{4}$ “	4 “	$2\frac{1}{2}$ “
Thickness internally . . .	2 “	$1\frac{3}{4}$ “	$1\frac{1}{4}$ “
“ externally . . .	$1\frac{1}{4}$ “	1 “	$\frac{3}{4}$ “

A small tooth, represented in figures 34, 35, resembles those of the third row outwardly from the median series of the recent *Z. Jussieu*, except that it is broader than usual in proportion to its fore and aft width. It is hexagonal, broader than wide, and thicker internally than externally. Its dimensions are as follow: breadth, $5\frac{1}{4}$ lines; width, 3 lines; thickness of the crown internally, $2\frac{3}{4}$ lines; externally, 2 lines. The root is broken away.

Another small tooth, represented in figures 36, 37, is unlike any with which I am familiar, and perhaps pertains to a different species from the preceding. It is from the outermost row of the dental series, and is about four times as broad as wide fore and aft. The inner end is rectangular and thick, and the tooth thins away outwardly to a sharp border. The outer end is rather abruptly curved backward. The measurements are as follow: breadth, 8 lines; width, 2 lines; thickness of the crown internally, $2\frac{1}{4}$ lines. The root is broken away.

Prof. Emmons, in his Report of the North Carolina Geological Survey for 1858, page 243, has represented several isolated median teeth, under the name of *Trygon carolinensis*, from the eocene marl of Craven Co., North Carolina. They resemble specimens from Ashley River attributed to *Zygobates dubius*, and perhaps pertain to the same.

CERATOPTERA.

CERATOPTERA UNIOS.

Leidy: Proceedings Academy of Natural Sciences of Philadelphia, 1876, 86.

Among the fossils of the Ashley phosphate beds, an interesting one recently obtained is the specimen represented in figures 1, 2, Plate xxxiv. It appears to

be the bone, corresponding with that existing in the living Devil-fish, *Ceratoptera vampirus*, at the root of the tail and supporting a minute spine, the rudiment of the formidable barbed spines of the Sting-rays. Compared with the bone of the living Devil-fish of our southern coast, as represented in figures 2, 3, Plate 3, of Prof. Holmes' description of the American Devil-fish, published in the Proceedings of the Elliott Society for 1856, the fossil presents sufficient differences to render it probable that it belongs to a distinct species. The fossil is about as long, but nearly double the breadth and height of the bone in the recent fish, and also presents other important differences.

The fossil knob forms a cone with striated sides sloping from an elongated ridge. The base is nearly flat and rugged, and has an irregular ovoid outline with the narrower end directed posteriorly.

The ridge of the summit is most prominent and obtuse in front, and it becomes more acute and gradually slopes off posteriorly. A narrow somewhat interrupted groove extends along its intermediate part. In front and at the sides narrow ridges separated by furrows descend from the summit of the knob in a radiant manner to the irregularly scalloped border of the base. The front slope is somewhat defined from those of the sides by greater prominence of the surface. Posteriorly a strong escarpment rises from the base of the bone into a thick, obtuse, transverse ridge, nearly on a level with the posterior end of the summit of the knob. The transverse ridge having offsets converging from the ends to the sides of the knob, incloses a transverse groove. The position of attachment of a rudimental spine, if such existed, is not obvious.

The length of the base of the fossil is $3\frac{1}{4}$ inches, the breadth 2 inches; the height of the summit at its fore part from a level, $1\frac{1}{2}$ inches.

Supposing the fossil to indicate an extinct and previously unknown species, I have proposed for it the name heading this article.

GRYPHODOBATIS.*

GRYPHODOBATIS UNCUS.

Figures 8 and 9 of Plate xxxiv. represent a tooth, twice the natural size, from the Ashley phosphate beds, which may be the symphysial tooth of a Shark, or perhaps the tooth of a Ray. The crown is a narrow curved cone with a laterally expanded base, and twice the length on its external face that it is on the inner face. The point curves inward and posteriorly. The outline of the base in front

* Contracted from Gryphodontobatis.

is convex. The outer lateral border presents a single denticle a short distance from the summit. The root extends below the crown with a prominent obtuse convex border, and projects backward in a broad trilobate base, as seen in figure 9.

Length of the tooth in front, $4\frac{3}{4}$ lines; breadth, $3\frac{1}{2}$ lines. Length of the crown in front, $3\frac{1}{2}$ lines. Height of base of root posteriorly, $3\frac{3}{4}$ lines; breadth, $3\frac{1}{4}$ lines.

ACRODOBATIS.*

ACRODOBATIS SERRA.

Among the fish teeth occurring in collections of fossils from the Ashley phosphate beds, I have noticed a number which appear to pertain to a species of Ray. Teeth of the kind are represented in figures 10–13, Plate xxxiv., twice the natural size. They may perhaps be symphysial teeth of a Shark.

The crown of these teeth is usually wider than high, and the base is extended downward at the middle in a rounded prominence, and backward posteriorly in a similar prominence. The summit rises in a tapering point, and the lateral acute borders exhibit seven or eight denticles successively decreasing towards the base. The teeth of figures 10, 11, have the main point worn off and the lateral denticles more or less abraded. The tooth of figure 12 has the main point partially worn off; and even that of fig. 13 has the extreme point somewhat blunted by abrasion.

The root of these teeth is a shallow basis with a trilateral outline, the angles rounded and the lateral ones slightly projecting.

ACRODOBATIS OBLIQUUS.

Figure 14, Plate xxxiv., represents a tooth nearly like those just described, but having the main point directed to one side so as to recall to mind the teeth of *Galeocerdo*. The specimen was obtained in the marl of Monmouth Co., New Jersey, and was presented to the Academy by Dr. Knieskern. The inner acute border of the crown is the longer, and is convex in its course from the base of the main point. It presents seven denticles successively decreasing in size. The outer side presents two larger denticles succeeded by four minute ones. The construction of the base of the crown is like that of the preceding teeth.

Length of the tooth, 3 lines; breadth, $3\frac{1}{4}$ lines; thickness at base, $2\frac{3}{4}$ lines.

I have regarded the tooth as representing a species distinct from that to which the Ashley fossils pertain, under the name above given.

* Contracted from *Acrodontobatis*.

XENODOLAMIA.*

XENODOLAMIA PRAVUS.

Shark teeth of an unusual form, from the Ashley phosphate beds, are represented in figures 33-36, Plate xxxiv. I have supposed that these may be symphysial teeth of *Carcharodon megalodon*, or perhaps of *C. angustidens*, but I have not been able to determine the question. Nor is it positive that all these teeth pertain to the same species or genus.

In all the specimens the root exceeds the crown in bulk, and in comparison with the usual condition of the root in the teeth of Sharks has the appearance of being deformed.

In the largest tooth, figure 33, the crown is demi-conical, somewhat tapering and nearly straight, and its lateral acute borders are denticulate. The length and breadth of the root are nearly equal, and both are much greater than the length of the crown. It forms a prominence at the base of the crown to one side of the middle nearly as thick as the length of the crown on its inner face. The processes of the crown form two cones projecting in the same direction obliquely. Length of the tooth from the bottom of the root notch, 10 lines; length of crown medially and posteriorly, $5\frac{1}{2}$ lines; breadth at base, 8 lines; greatest length of root, 8 lines; breadth, $8\frac{3}{4}$ lines; thickness, $4\frac{1}{2}$ lines.

The tooth represented in figure 34 is about half the size of the preceding. The crown is oblique and more expanded laterally at the base, and the borders are more distinctly denticulated. The inner process of the root is proportionately less prominent and the outer one is undeveloped.

Length of the tooth from the point to the notch of the root, $5\frac{1}{2}$ lines; length of crown on the posterior face, 3 lines; breadth at base, $5\frac{3}{4}$ lines.

XENODOLAMIA SIMPLEX.

The remaining pair of teeth perhaps belong to a different species and genus. The crown is very much smaller in proportion to the root than in the former, and its lateral borders are not denticulated.

The tooth represented in figure 35 has a small oblique, demiconoidal crown with a rather wide and slightly recurved summit. The root is of comparatively enormous proportion, and resembles in shape that of the large tooth first described.

Length of the tooth from the root notch, 5 lines; length of crown, $1\frac{1}{2}$ lines; breadth at base, $2\frac{3}{4}$ lines; length of root, $6\frac{3}{4}$ lines; breadth, 7 lines.

* Contracted from Xenodontolamia.

The tooth of figure 36 has the crown proportionately larger and the root thicker but narrower, and with but feebly developed processes.

Length of the tooth, 6 lines; length of the crown, 2 lines; breadth at base, $3\frac{1}{2}$ lines; length of crown at middle, $4\frac{1}{2}$ lines; breadth, 4 lines; thickness, 3 lines.

XIPHODOLAMIA.*

XIPHODOLAMIA ENSIS.

While engaged in describing some unusual forms of the teeth of Sharks, I take the opportunity of noticing another from the marls of New Jersey. The teeth to which I refer are probably symphysial, but their relationship with lateral associates remains undetermined. The museum of the Academy contains twelve of these teeth, of which six are from Vincenttown, presented by Col. T. M. Bryan; four from Monmouth Co., presented by Dr. P. Knieskern; one from Burlington Co., presented by Dr. C. C. Abbott; and one from Allowaystown, presented by Dr. H. C. Yarrow. The teeth have the general appearance of those of *Lamna* laterally compressed.

The crown of the tooth usually, as represented in figures 25-28, Plate xxxiv., has a sigmoid sabre-like form with the anterior border sharp and the posterior border obtuse. The root has the construction of that of a *Lamna* tooth, but the two sides appear pressed towards each other, so that the processes are directed obliquely and parallel. In some teeth, as in figure 27, the processes are nearly or quite equal; in other teeth, as in figures 25, 26, one process is shorter than the other.

Figures 29 and 30 represent transitional forms from that above indicated to the more ordinary one of *Lamna* teeth. In one of these, fig. 29, the crown is sharp a short distance below the point on the outer border, as it is the entire length along the inner border; in that of fig. 30 the crown is sharp along both borders. The root in both teeth is not laterally compressed, but has nearly the common form seen in most teeth of Sharks.

PRISTIS.

PRISTIS ENSIDENS.

Leidy: Proceedings Academy of Natural Sciences, Philadelphia, 1855, 414.

Multitudes of isolated teeth of several species of Saw-fish have been found in the Ashley phosphate beds. From among a number of specimens in the museum

* Contracted from Xiphodontolamia.

of the Academy, a long time ago described by me under the above name, two are selected and represented in figures 31, 32, Plate xxxiv. The teeth are straight, and have both borders alike and subacute.

The larger tooth is an inch and a half long and half an inch broad; the smaller tooth is 11 lines long and 5 lines broad.

CARCHARODON MEGALODON.

Multitudes of teeth referable to this species are obtained from the phosphate beds of South Carolina. Among them are some which exceed in size those which have been reported from other localities. The following notes of measurements were taken from some of the largest specimens observed:—

1. A tooth, contained in a show-case of the Bradley Fertilizer Co. in the Agricultural Hall of the International Exhibition, from the phosphate beds of the Company on the Stono River, measures 6 inches 8 lines in length from the level of the ends of the fangs to the end of the tooth, and is 4 inches 8 lines in width across the base.

2. A second specimen, in the same collection from the same locality, is 6 inches in length, and 5 inches 1 line in breadth.

3. A specimen, from the Ashley River, formerly in the possession of Professor Holmes, measures 6 inches 5 lines long, 5 inches 5 lines broad, and weighs 2 lbs. 3 drs., apothecaries' weight.

4. A second specimen, from the same locality, has the same length, and is 4 inches 10 lines in breadth.

5. Two additional specimens, from Ashley River, measure 5 inches 10 and 11 lines in length, and 4 inches 6 and 7 lines in breadth.

6. A specimen, from a railroad cutting 27 miles from Charleston, purporting to be derived from the eocene marl, is 5 inches 8 lines long, and 4 inches 5 lines broad.

Besides the foregoing, among the multitude of teeth of Sharks, observed in the various collections of fossils from the South Carolina phosphate beds at the International Exhibition, I noted particularly those of the following species:—

CARCHARODON ANGUSTIDENS. Abundant.

In the collection of the Bradley Fertilizer Co., in Agricultural Hall, there is a specimen of a large tooth of this species, imbedded in a hard phosphatic nodule about the size of two fists. The projecting crown is about $2\frac{3}{4}$ inches in length, with the base about 2 inches in width. The specimen was derived from the Bulow tract between Ashley and Stono Rivers.

The collection contains many other teeth of the same species, together with teeth of *Carcharodon megalodon* and other Sharks, and a well-preserved dental pavement of *Myliobates mordax*.

With these there were also vertebræ of Sharks; among them one of a *Carcharodon* $3\frac{6}{10}$ inches broad and $1\frac{1}{10}$ inches long; another measured $3\frac{1}{2}$ inches broad and $1\frac{2}{5}$ inches long.

The collection further contains vertebræ, teeth and ear bones of Cetaceans, and teeth of Elephant, Mastodon, Horse, and a Deer, all obtained from the Bulow tract.

CARCHARODON LANCIFORMIS. Moderately frequent.

NOTIDANUS PRIMIGENIUS. Seldom.

HEMIPRISTIS SERRA. Abundant.

GALEOCERDO ADUNCUS. Moderately frequent.

GALEOCERDO CONTORTUS. Abundant.

PRIONODON ANTIQUUS, Agassiz.

Galeocerdo minor, Gibbes. Abundant.

LAMNA ELEGANS. Frequent.

OXYRHINA HASTALIS. Moderately abundant.

OXYRHINA XIPHODON. Moderately abundant.

SPHYRÆNA MAJOR.

Leidy: Proceedings Academy Natural Sciences, 1855, 397.

Isolated teeth of a large species of *Sphyræna* are frequent among the fossils of the Ashley phosphate beds. The first specimens brought to my notice were obtained by the late Capt. Bowman from the sands of Ashley River. All that I have examined, perhaps amounting to several hundred, have been shed teeth, or such as had not had the root developed.

Figures 37, 38, Plate xxxiv., represent teeth of the ordinary form. These appear to be somewhat broader in proportion to their length than in the great Barracuda Pike. They are flattened conical, with trenchant borders and sharp point. The borders and point are defined from the body of the tooth by a delicate line, and the edges when unworn are minutely crenulate. The lustrous enamel-like dentinal investment of the teeth is regularly and minutely striate in the length; in some specimens the striæ becoming more distinct towards the base.

Figure 39 represents a tooth of similar form to those just described, but presenting a coarsely striated appearance towards the base.

Figures 40, 41, represent teeth like those arming the anterior extremity of the mandibles and intermaxillaries in the Barracuda Pike. These are compressed

conical, with the anterior border trenchant and the posterior border obtuse. They are slightly bent backward from near the base, and have a slight posterior barb-like projection to the point. The largest specimen is more coarsely striate at the base than in the smaller ones, and it also exhibits an excavation produced by the encroachment of its successor.

DIODON VETUS.

Leidy: Proceedings Academy Natural Sciences, 1855, 397.

Diodon antiquus, Leidy, Cope: Kerr's Report Geol. Survey of North Carolina, 1875, Appendix 31, Plate viii., fig. 6.

Among the fossils of the Ashley phosphate beds there not unfrequently occur specimens of the dental armature of a species of *Diodon*. The first specimens brought to my notice were obtained by the late Capt. A. H. Bowman, U. S. A., in sand dredged from the Ashley River, and were described in the Proceedings of this Academy for 1855. As usual with the Ashley fossils, the remains of the *Diodon* consist only of the hardest part of the skeletal structure—the dental armature devoid of the osseous jaws.

In the existing Striped Balloon-fish (*Diodon maculo-striatus*, *Chilomycterus geometricus*), the exposed margins of the jaws are occupied with a dental armature forming a crescentoid band composed of a multitude of small flattened denticles co-ossified with one another and with the jaw. Within the position of the marginal dental armature there is a second, appearing as a large tubercle, composed of broad laminar denticles arranged in two piles. These piles are co-ossified in the median line and with the marginal dental armature in front, as well as with the jaw itself, the whole together forming a solid mass.

The fossils consist of the marginal and the internal or oral dental armatures retained in conjunction, or separated, and frequently of the elements of the same more or less isolated. The decomposing effect of the water to which the remains were subjected, has rendered the structural elements of the dental armature more distinct than in recent specimens. From among a number of the fossils two of the most complete are represented in figures 15, 16, Plate xxxiv., and they consist of the marginal dental armature still retained in conjunction with the interior or oral dental armature.

In one of the specimens, figure 15a, the oral dental tubercle is worn concavely with the hollow directed backward; in the other, figure 16, it is worn convexly, indicating that this was opposed to the former. A similar difference between the oral dental tubercles of the upper and lower jaw is scarcely obvious in several specimens of our common Striped Balloon-fish which I have examined.

The marginal dental armature is composed of a number of horizontal rows of small curved quadrate plates associated by intervening ossific substance. The anterior face of the armature resembles that of a wall built of tiles imbedded in mortar.

The oral dental armature is made up on each side of about ten plates united by cementum. The unworn plates, as seen on the surface of the piles opposite the triturating surface, are variable in outline in different specimens, as represented in figures 15*b* and 18. The differences might be suspected to be specific, but in eight specimens no two are alike.

The age of the fossils, like many others of the Ashley phosphate beds, is uncertain. They are supposed to be derived from the so-called eocene marl rock.

Professor Cope has indicated specimens from the miocene of North Carolina (Kerr's Report of the Geol. Surv. of N. C., 1875, Appendix, p. 31, Pl. viii., fig. 6), which he attributes to the same species, but inadvertently ascribes them to me under the name of *Diodon antiquus*.

PHARYNGODOPILUS.

Specimens of pharyngeal bones thickly crowded with molar teeth, found in miocene and pliocene formations of Europe and Africa, have been referred by Prof. Igino Cocchi of Florence, to an extinct genus of labroid fishes under the above name. (Monografia dei Pharyngodopilidæ, Firenze, 1864.)

PHARYNGODOPILUS CAROLINENSIS.

Odax carolinensis, Leidy: Proceedings Academy Natural Sciences, 1855, 396.

Specimens of isolated pharyngeals thickly crowded with teeth, resembling those referred to the above genus, are occasionally discovered in the Ashley phosphate beds of South Carolina. Specimens of the kind, together with others of maxillaries and teeth, obtained by the late Capt. Bowman from the sands of Ashley River, were described by me in the Proceedings of this Academy in 1855, under the name of *Odax carolinensis*.

Figure 19, Plate xxxiv., represents an inferior pharyngeal, so closely crowded with teeth that scarcely a vestige of the bone in which they are imbedded is visible. The largest teeth are central and posterior. The original form of the teeth as seen on the masticating surface, would appear to have been hemispherical, but in many cases, from their crowded condition, they have assumed a more or less irregular form. The surface of the pharyngeal bone opposite to the masticating pavement of teeth is crowded with fewer and larger empty cavities of reserve for teeth.

The pharyngeal bone with its imbedded mass of teeth, reminding one of a fused mass of discolored beads such as one occasionally meets with from some burned-down house, is in the shape of a broad triangle with the apex in front and the thickened base directed backward. Prof. Cocchi describes the corresponding bone in a reversed direction from that here given, and which appears to me to correspond with that of the position of the inferior pharyngeal in the Wrasse and the Tautog.

Figure 20 represents another specimen from a smaller individual if not another species. The posterior teeth are much more numerous in the same extent of space than in the preceding specimen, but perhaps this difference would be dependent on difference of age.

Figure 21 represents a superior pharyngeal with its closely impacted teeth. The form of the horizontal section is half crescentic devoid of the point. The larger teeth are internally situated, and the greater number appear on the hinder surface. In the latter position most of the teeth are arranged with more regularity than on the lower surface, or on either masticating surface of the upper pharyngeal.

Prof. Cocchi in his monograph describes no maxillaries referable to *Pharyngodopilus*. Several specimens from the Ashley phosphate beds I have supposed to pertain to the same labroid fish as the pharyngeals above described.

Figure 22 represents a mutilated maxillary with the lower portion retaining the remains of a dental armature. This on the outer surface presents a tessellated appearance as in the Parrot fishes, due to a number of small denticles arranged quincuncially and decreasing in size outwardly. At the margin of the jaw the denticles form a row of compressed ovoid points adapted to biting. Along the symphyseal margin of the jaw there is a single longitudinal row of five conical teeth with an additional pit in advance from which a tooth has been shed. The two teeth in front are double the size of the others.

Figure 23 represents the dental armature of a mandible, with the outer face covered with denticles in quincunx arrangement as in the Parrot fishes. At the biting margin of the jaw a row of denticles forms a serrated edge of compressed ovoid points. Along the symphyseal margin internally there is a single horizontal row of four short conical teeth.

Figure 24 represents another specimen in which the denticles on the outer face of the jaw are more widely separated by intervening cementum. The inner part of the jaw is not so deep or appears less excavated than in the former, and along the symphyseal border there is a horizontal row of five teeth.

EXPLANATION OF PLATES.

PLATE XXX.

Figs. 1-5. Detached beaks of Ziphioid Cetaceans, reduced to one-third the size of the specimens.

1. *CHONEZIPHIUS LIOPS*. Upper view of a detached beak.
2. *CHONEZIPHIUS TRACHOPS*. Upper view of a detached beak.
3. *DIOPLODON PROROPS*. Upper view of a detached beak.
4. Left lateral view of the same specimen.
5. *EBOROZIPHIUS CÆLOPS*. Upper view of a detached beak.
6. *ROSMARUS OBESUS*. Inner view of the left tusk. One-third the natural size.
- 7-11. Teeth of Cetaceans, of the natural size.
7. Tooth resembling those of the Sperm Whales, from the Ashley phosphate beds.
8. Tooth of a similar character, from the same beds.
9. Cetacean tooth, resembling that of a Grampus, from the same beds as the preceding.
10. Cetacean tooth, from the Miocene marl of Nash Co., North Carolina.
11. Cetacean tooth, found with the preceding.

PLATE XXXI.

Figs. 1-3. Right lateral view of the detached beaks of the following Ziphioid Cetaceans, one-third the natural size:—

1. *CHONEZIPHIUS TRACHOPS*.
2. *CHONEZIPHIUS LIOPS*.
3. *EBOROZIPHIUS CÆLOPS*.

All the remaining figures, consisting of the dental armature of Rays, are of the natural size.

- 4, 5. *MYLIOBATES JUGOSUS*. Tooth from Vincenttown, New Jersey.
4. View of the triturating surface. 5. Anterior view of the tooth.
- 6-10. *MYLIOBATES OBESUS*. 6. View of the triturating surface of a median tooth.
7. Posterior view of the same tooth. Specimen from Mullica Hill, Gloucester Co., N. J.
8. Plate consisting of two median teeth, seen on the triturating surface.
9. Posterior view of the specimen. From Vincenttown, N. J.
10. Dental plate, viewed on the triturating surface. From New Egypt, Ocean Co., N. J.
11. *MYLIOBATES FASTIGIATUS*.
- Dental plate, viewed on the triturating surface. From Monmouth Co., N. J.
- 11a. Outline of a transverse section with the crown directed downward.
12. *MESOBATIS EXIMIUS*.
- Fragment of an inferior dental plate. From the sands of Ashley River, S. C.
13. *ÆTOBATIS PERSPICUUS*. Fragment of a tooth. From Monmouth Co., N. J.
- 14-18. *ÆTOBATIS ARCUATUS*, Cope.
- Fragments of teeth, from the miocene of Charles River, Maryland.

- 14. Left half of an inferior tooth. 15. Median portion of an inferior tooth.
- 16. Inferior tooth with the left extremity lost.
- 17. The right portion of a superior tooth.
- 18. Portion of the left side of a superior tooth.
- 19, 20. *ÆTOBATES PROFUNDUS*, Cope. Teeth found mingled with the preceding.
- 19. An anterior tooth of the lower dental series.
- 20. The left portion of a similar tooth.
- 21-37. *ZYGOBATES DUBIUS*. Isolated teeth, from the sands of Ashley River, S. C.
- 21. A median unworn tooth, seen on the triturating surface.
- 22. Anterior view of the same; the root lost.
- 23. Anterior view of a median unworn tooth.
- 24. Triturating surface of a worn median tooth.
- 25. Anterior view of the same tooth.
- 26. Triturating surface of a worn median tooth.
- 27. Posterior view of the same tooth.
- 28. Triturating surface of a first lateral tooth.
- 29. Posterior view of the same tooth.
- 30. Triturating surface of a first lateral tooth.
- 31. Posterior view of the same tooth.
- 32. Triturating surface of a first lateral tooth.
- 33. Posterior view of the same tooth.
- 34. Triturating surface of a second lateral tooth.
- 35. Posterior view of the same tooth; the root lost.
- 36. Triturating surface of an external lateral tooth.
- 37. Posterior view of the same tooth; the root lost.

PLATE XXXII.

Figs. 1-4 Represent detached beaks of Ziphioid Cetaceans, from the Ashley phosphate beds, one-third the diameter of the originals.

1, 2. *PROROZIPHIUS MACROPS*.

1. Upper view of a detached beak or rostrum. 2. Left lateral view of the same.

3, 4. *PROROZIPHIUS CHONOPS*.

3. Upper view of a detached beak. 4. Right lateral view of the same.

5-7 Represent the dental armature of Rays, of the natural size.

5. *MYLIOBATES SERRATUS*. Inferior dental plate.

5a. Transverse section of the same. Specimen from Pemberton, Burlington Co., N. J.

6. *MYLIOBATES PACHYODON*, Cope. Fragment of an inferior dental plate.

6a. Transverse section of the same, with the crown reversed or directed downward. From the miocene tertiary of Charles Co., Md.

7. *MYLIOBATES*. Portion of an inferior dental plate.

7a. Transverse section of the same. From the same locality as the preceding.

PLATE XXXIII.

Exhibits the dental armature of Rays, with the fore part or worn extremity directed upward.

All of the natural size.

Figs. 1-3. *MYLIOBATES MORDAX*. 1. An inferior dental plate; the right half alone represented.

Specimen from the Ashley phosphate beds.

2. A second specimen, from the same locality.

2a. A transverse section of the same, with the crown directed upward.

3. A superior dental plate, probably of the same species. From the same locality.

4. *MYLIOBATES GIGAS*, Cope.

A superior dental plate. From the miocene tertiary of Charles Co., Md.

5. *MYLIOBATES VICOMICANUS*, Cope.

An inferior dental plate. Found with the preceding.

6. *MYLIOBATES FASTIGIATUS*. A superior dental plate.

6a. Transverse section of the same, with the crown directed downward. From Monmouth Co., N. J.

7. *MYLIOBATES MAGISTER*.

An inferior dental plate. From the Ashley phosphate beds.

PLATE XXXIV.

Figs. 1, 2. *CERATOPTERA UNIOS*. Figures of the natural size. Bony knob of the tail.

1. Upper view. 2. Lateral view, the hinder extremity directed towards the left.

3. *TRIONYX*. Fragment of a costal plate, half the natural size.

4, 5. *EUPACHEMYS OBTUSUS*.

Figures half the natural size. A marginal bone of the carapace.

4. Upper view. 5. View of the posterior sutural surface; the upper surface of the bone directed towards the left, and the inner margin of the bone upward.

6. *DINOZIPHIUS CAROLINENSIS*. A tooth, one-half the natural size.

7. *CETERHINOPS LONGIFRONS*. Upper view of a fragment of the skull, one-half the natural size. The occipital extremity is uppermost.

8, 9. *GRYPHODOBATE UNCUS*. A tooth magnified two diameters.

8. External or anterior view. 9. Internal or posterior view.

10-13. *ACRODOBATE SERRA*.

Four teeth, viewed on the anterior or external face, magnified two diameters.

10. Tooth with the principal point worn off. 11, 12. Teeth less worn.

13. Tooth retaining its principal point.

14. *ACRODOBATE OBLIQUUS*.

Tooth magnified two diameters, external view. Specimen from Monmouth Co., N. J.

15-18. *DIODON VETUS*. Dental armature of the jaws, natural size.

15a. Dental armature of the lower jaw, viewed on the upper or oral surface.

15b. The same specimen seen on the under surface.

16. Dental armature of the upper jaw, viewed on the under or triturating surface.

17. View of the triturating surface of two piles of oral plates from another specimen.

18. View of the upper surface of the same specimen.

19-24. PHARYNGODOPILUS CAROLINENSIS.

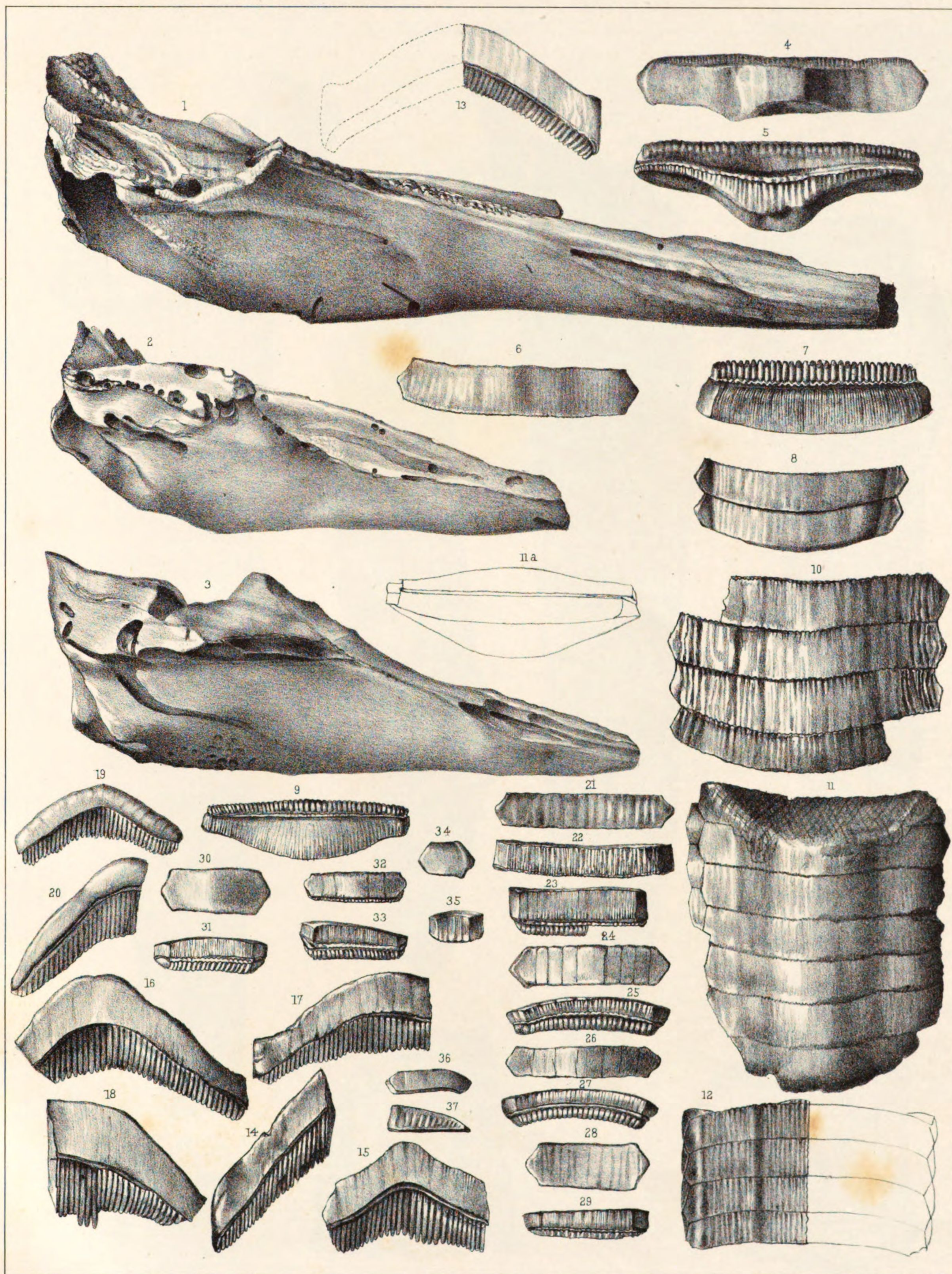
Dental armature of the jaws and pharyngeals, magnified two diameters.

19. Dental armature of the inferior pharyngeal.
20. A similar specimen from another individual.
21. Dental armature of a superior pharyngeal.
22. A mutilated upper maxillary with part of the dental armature.
- 23, 24. Dental armature of two mandibles, viewed externally.
- 25-30. XIPHODOLAMIA ENSIS. Teeth, of the natural size.
- 25, 26. Two views of a tooth, from Vincenttown, N. J.
27. A similar tooth, from Burlington Co., N. J.
28. A smaller tooth, from Monmouth Co., N. J.
- 29, 30. Teeth, from Vincenttown, N. J.
- 31, 32. PRISTIS ENSIDENS. Two teeth of the natural size.
- 33, 34. XENODOLAMIA PRAVUS. Posterior view of two teeth, of the natural size.
- 35, 36. XENODOLAMIA SIMPLEX. Posterior view of two teeth, of the natural size.
- 37-41. SPHYRÆNA MAJOR. Teeth, of the natural size.
37. Tooth—probably a lateral premaxillary tooth.
- 38, 39. Lateral mandibular teeth.
- 40, 41. Anterior barbed teeth.
- 42, 43. MEGATHERIUM. A first lower molar tooth, of the natural size.
42. Triturating surface. 43. External view.
44. MYLIOBATES OBESUS.
- Natural size. Two mutilated median teeth. From Pemberton, Burlington Co., N. J.
45. Tooth of a Shark, from the cretaceous formation of Bexar Co., Texas. Natural size.
- Specimen recently loaned for examination by Mr. G. W. Marnock.



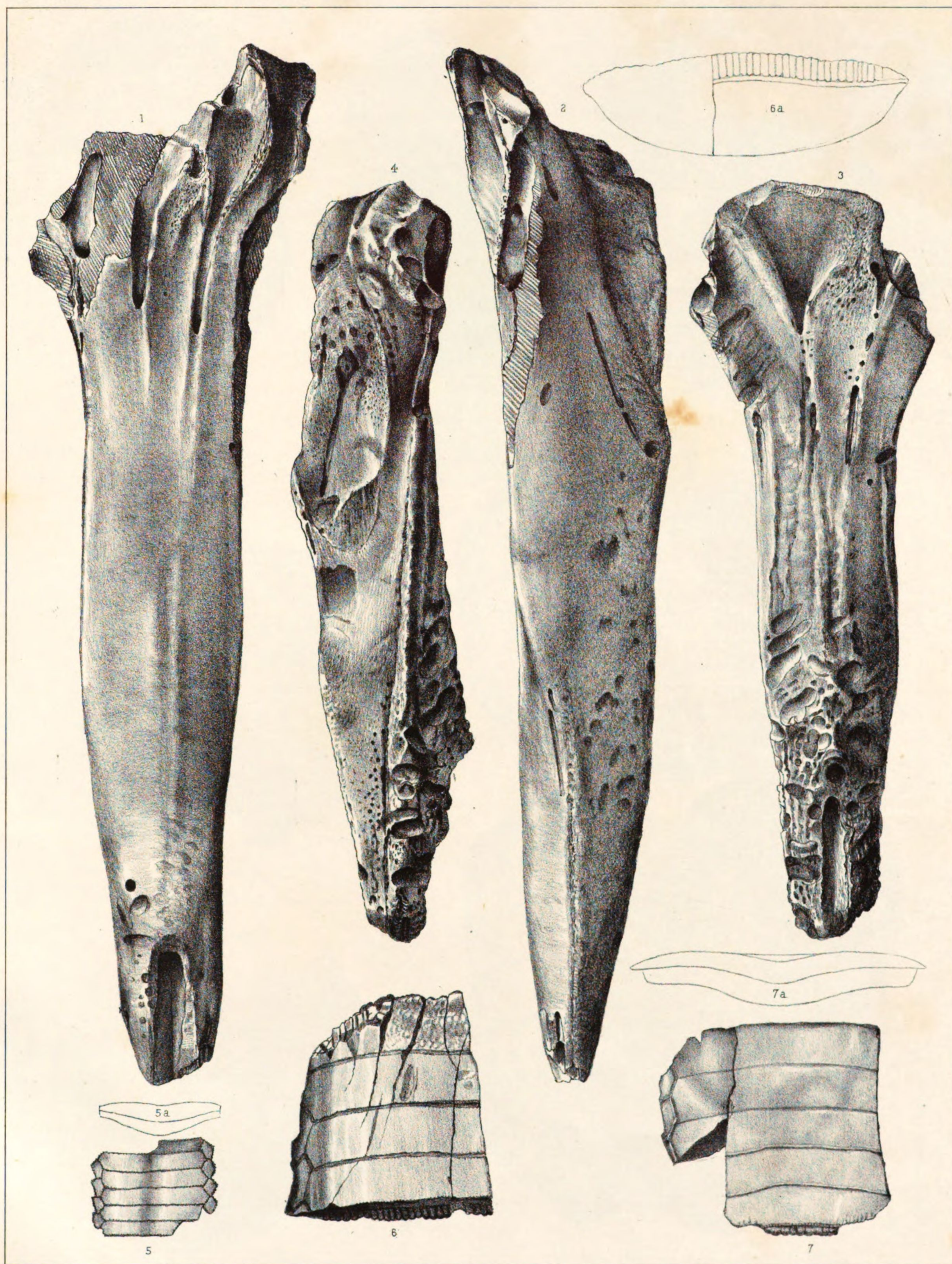
T. Sinclair & Son, lith. Phila.

1 Choneziphius liops. 2 C. trachops. 3-4 Dioplodon prorops. 5 Eboroziphius coelops. 6 Rosmarus obesus. 7-11 Cetacean teeth.



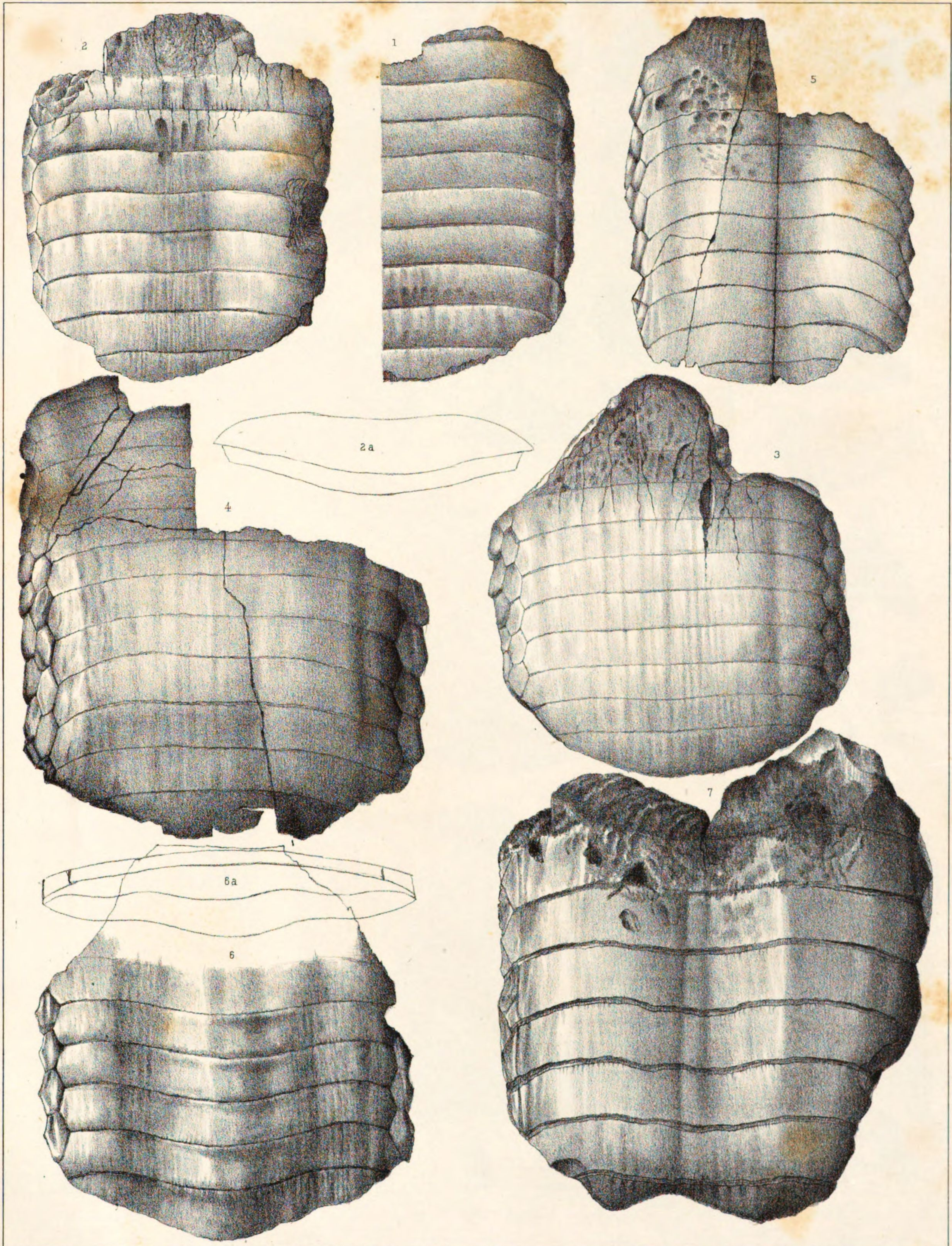
T. Sinclair & Son, lith. Phila.

1 Choneziphius trachops. 2 C. liops. 3 Eboroziphius coelops. 4-5 Myliobates jugosus. 6-10 M. obesus. 11 M. fastigiatus.
12 M. eximius. 13 Aetobatis perspicuus. 14-18 A. arcuatus 19-20 A. profundus. 21-37 Zylobates dubius.



T. Sinclair & Son, lith. Phila.

1 2 *Prorhiziphus macrops*. 3-4 *P. chonops*. 5 *Myliobates serratus*. 6 *M. pachyodon*. 7 *Myliobates*.



T. Sinclair & Son, lith. Phila.

1-3 *Myliobates mordax*. 4 *M. gigas*. 5 *M. vicomitanus*. 6 *M. fastigiatus* 7 *M. magister*.



1-2 *Ceratoptera unios*. 3 *Trionyx*. 4-5 *Eupachemys obtusus*. 6 *Dinoziphius carolinensis*. 7 *Ceterhinops longifrons*.
 8-9 *Gryphodobatis unicus*. 10-13 *Acrodobatis serra*. 14 *A. obliquus*. 15-18 *Diodon vetus*. 19-24 *Pharyngodopilus carolinensis*.
 25-30 *Xiphodolamia ensis*. 31-32 *Pristis ensidens*. 33-34 *Xenodolamia pravus*. 35-36 *X. simplex*. 37-41 *Sphyraena major*.
 42-43 *Megatherium*. 44 *Myliobates obesus*. 45 Shark tooth from Texas.

Leidy, Joseph

Description of Vertebrate Remains, Chiefly from the Phosphate Beds of
South Carolina Extracted from the Journal of the Academy of Natural
Sciences, vol. 8., Philadelphia, 1877. (S. 209 - 261. 5 Taff.)

Philadelphia 1877

4 Lith. 98 k

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